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EVALUATION OF DECORATIVE PROPERTIES OF SOME CONIFEROUS PLANTS INTRODUCED TO ABSHERON PENINSULA

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Abstract: *The advancement of the vegetation cover of various regions can be considered as the most significant issue of commercial consequence. Plants that are less demanding on fertile soil, relevant for prevention of soil erosion, better purify the atmosphere and enrich it with oxygen have always been in the focus of researchers. From this point of view, the article is dedicated to the description of the perspective use of introduced species of coniferous plants in the greening and beautification of Absheron peninsula. The presented article is committed to the objective assessment of decorativeness coefficient of some coniferous plants introduced to the Absheron Peninsula. It is known that the formula calculation is very important for the comparative study of the decorative properties of different species coniferous plants used in landscaping since ancient times. For this purpose, the adapted form of the method proposed by Babich was developed and the decorative properties of a number of conifers were calculated.*

Keywords: *Absheron, peninsula, coniferous, decorative, plants*

Introduction: It is known that the development of the cultural flora of the regions, enrichment with new species, taking into account the ecological and botanical features, is one of the most significant issues of economic importance. From this point of view, the introduction of plants in accordance with the landscape, botanical-geographical conditions of the region and the characteristics of the surrounding objects are very relevant. The use of the term "Introduction" in botany dates back to the times when agriculture first began to develop, when people from primitive community structures tried to find and cultivate plants

close to their place of residence, which were low-maintenance and at the same time had nutritional and medicinal value. The field of introduction of decorative plants, which requires deep knowledge in landscape design and botany, is a very young field and has developed since the beginning of urban planning. At the present level of development of science and technology, as a result of the relative decrease in the level of use of the products of natural plant communities and the increasing level of use of the products of plant agrocenoses of important economic importance, there is an interest in expanding the introduction of plants as field of science.

It should be noted that the science of plant introduction has different branches and directions. Thus, the development of introduction science promotes the development of theoretical and practical knowledge, as well as the development of agricultural sciences, and at the same time lays the groundwork for the study of plant phenology and biology. For this purpose, expansion of planned and implemented works, enrichment of species composition of flora increases the possibilities of using plant varieties in greening, phytomelioration, agriculture and forestry.

In the conditions of the development of modern ecological ideas and outlook, the problem of creating green spaces and parks for the purpose of nature protection has always been in the center of attention. Emphasizing the importance of all this, it should be noted once again that in the world experience, in the construction of large industrial cities and urban-type settlements, first of all, solutions to the issues of organizing a green belt around them are investigated. When we say green lines, we mean parks, forest parks and all areas under perennial green plants of various life forms located around the important facilities of the city's infrastructure. In this regard, cities should not consist only of construction structures, special attention should be paid to the proper organization of the greening of the facilities. The main goal of organizing green lanes is to significantly reduce the amount of toxic gases, purify the air and enrich it with oxygen, reduce the noise level, and ensure effective recreation of the population. However, along with all these positive features, it should be noted that the area where the green belts will be located should be included in the project planning in advance, taking into account the geographical and climatic characteristics.

Green zones can also be artificially created around large cities and industrial facilities. In this case, the species composition of the biocenosis to be artificially created its location and maintenance rules are planned in advance. In general, when creating artificial biocenoses, preference is given to plant species that are less demanding on environmental factors and give an interesting and pleasant appearance all year round [Bazilevskaya, 1964]. In the organization of parks and recreation areas, plants are considered from the point of view of landscape design features, along with the features of protecting the soil from erosion, cleaning the air and disinfecting with phytoncides. It is possible to get a very interesting view by correctly placing plants belonging to different species and introduced to local conditions [Mammadov et al., 2000]. Depending on the characteristics of industrial enterprises, gas, soot, and dust-resistant species should be preferred when planting new crops, and plants with harmful fruits, leaves, and flowers should be used as little as possible in the yard of schools and gardens. When choosing trees and shrubs, in addition to their decorative properties, their bioecological properties should be taken into account and the planted greenery should be properly and timely cared [Mammadov et al., 2003]. In addition to the biological properties of the trees and shrubs to be planted in the area, their resistance to the local soil and climate conditions should be taken into account.

The object and methodology of research:

The object of the research are species used in greening on the Absheron Peninsula: *Juniperus sabina* L., *Juniperus polycarpus* C.Koch, *Juniperus foetidissima* Willd., *Cupressus sempervirens* L., *Pinus eldarica* (Medw.), *Pinus Kochiana*

Klotzsch ex Koch., *Thuja orientalis* L. (Figure 1)
Juniperus horizontalis Moench. (Figure 2).

The method proposed by Babich and others was used to calculate the coefficient of decorativeness of the studied plants. The mentioned method was adapted for conifers and the decorative perspectives of different species were compared [Babich et al., 2008].

Results: In an industrial center like Absheron, where northerly winds blow throughout the year, with a dry subtropical climate and sandy soils, and at the same time, the level of soil pollution with oil waste is high, there is a greater need for planting greenery and enriching its composition. From this point of view, taking into account the decorativeness of juniper trees, their lack of care and bio-ecological characteristics, their compatibility with local soil and climate conditions, the use of these species in greening works around Absheron and Baku is quite promising. At the same time, it should be specially noted that there is a great need to strengthen the sandy soils of the Absheron peninsula with plants with a deep root system. [Gurbanov et al. 2017]

In this point of view, conifers have several advantages over other plants:

- Conifers are not water-demanding and grow easily in sandy and clay podzol soils, which are widespread in our country.
- Conifers are long-lived. So, it is known that they can live for hundreds of years.
- They grow quite slow which makes them easy to care for. Since junipers are evergreen, they give an interesting and elegant "garden" look throughout the year.
- Finally, different species and varieties of conifers have very interesting crown shapes and colors. Their shapes are bell, spherical and pear-shaped. Their colors vary from dark green to blue-gray, light

green and even yellow green. This wide variety of colors and shapes can be used to create very interesting looking projects.



Fig. 1. *Thuja orientalis* L. in Absheron Peninsula



Fig. 2. *Juniperus horizontalis* Moench.
 (crown and berry-like cones)

The methodology proposed by Babich and others [Babich et al., 2008] was used in the description of the perspective of the use of the introduced species of coniferous plants used in the greening of the peninsula. Thus, the study of the variant of the methodology adapted to the study of coniferous plants shows that the decorative properties of the

plant and the perspective of its use in greening depend on a number of clusters.

Clusters can be grouped as follows:

1. Crown architecture (5 points)
2. Color of needle or scale like leaves (5 points)
3. Appearance of cones (5 points)
4. The aroma of cones and leaves (5 points)
5. The time the leaves stay on the plant (5 points)
6. Autumn color of leaves (5 points)
7. Resistance of the plant to pests and fungi (5 points)
8. Winter resistance (5 points)

A visual analysis of each of the studied plants was carried out on the mentioned clusters. At this time, in evaluating the structure of the crown, it should be considered that interesting forms can be obtained and that the care after the plant should be easy. The color of crown refers to the application of various shades of green in the preparation of landscape projects. The color and size of cones also should be considered as the main decorative feature.

The resistance of decorative plants to harmful fungi and insects is of decisive importance in their application in greening.

During the evaluation of the decorative feature of coniferous plants, the mentioned clusters should be collected by multiplying the coefficient of each of them (the coefficient of each clusters is equal to 2). The determination of the coefficient of decorativeness of coniferous plants used for greening in Azerbaijan is given in Table 1.

Discussion of results: After determining the coefficient of decorativeness for clusters, the analysis of decorativeness clusters of introduced species was carried out (Table 1).

In general species whose decorativeness coefficient is higher than 31 are considered promising, so all introduced species can be considered suitable for greening. However, among these species, *Juniperus sabina* L. which has a decorativeness perspective of 64, *Thuja orientalis* L. and which has a decorativeness perspective of 68, are considered more efficient for greening [Babich et al, 2008].

Table 1
Determining the coefficient of decorativeness of Coniferous plants
introduced to the Absheron Peninsula

Species	1	2	3	4	5	6	7	8	Coefficient of decorativeness
<i>Juniperus horizontalis</i> Moench.	4	5	5	3	5	0	4	5	62
<i>Juniperus sabina</i> L.	5	5	4	3	5	0	5	5	64
<i>Juiperus polycarpus</i> C.Koch	3	5	5	2	5	0	5	5	60
<i>Juniperus foetidissima</i> Willd.	3	5	5	1	5	0	5	5	58
<i>Cupressus sempervirens</i> L.	5	5	3	2	5	0	5	5	60
<i>Pinus eldarica</i> (Medw.)	3	5	4	2	5	0	5	5	58
<i>Pinus Kochiana</i> Klotzsch ex Koch.	3	5	3	2	5	0	5	5	56
<i>Thuja orientalis</i> L.	5	4	5	5	5	0	5	5	68

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EFFECTS OF CLIMATE CHANGE ON BIODIVERSITY IN THE EASTERN BLACK SEA REGION

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Abstract. Turkey contains a great variety of natural habitats, ranging from Mediterranean, Aegean, and Black Sea beaches to towering coastal and interior mountains, from deeply incised valleys to expensive steppes, from fertile alluvial plains to arid, rocky hillslopes. The richness in the diversity of habitats translates into richness in the biodiversity in Turkey. But, because of rapid human population growth (about 2.5% per year) and associated intensive or unwise utilization of natural resources and habitats the biodiversity of Turkey is deteriorating. Eastern Black Sea Region of Turkey is rich in biodiversity compared to other regions. The east-west oriented, parallel ranges of the Northern Anatolian Mountains run in the southern part of the Eastern Black Sea. Climate change will significantly influence the biodiversity of the region according to future climate scenarios for the region. We used existing literature related to flora and future climate of the region and field observations done in the different times to assess biodiversity in the region. Future climate of the region has been predicted by the Dalfes et al. (2007) using RegCM3 regional climate model.

The region has total of around 2500 plant species and 386 of them are endemic. High mountain areas in Artvin, Rize and Trabzon are the places rich in endemism. Eight of the endemics are in the critically endangered list of IUCN while 55 are in endangered list in the region. The numbers of total species in each city are 1219 for Artvin, 747 for Rize, 894 for Trabzon, 457 for Giresun and 301 for Ordu. Numbers of endemic species in each city are 119 for Artvin, 74 for Rize, 70 for Trabzon, 54 for Giresun and 19 for Ordu.

According to future climate scenarios, the eastern part of the region will get 200-300 mm increases in precipitation, while the western part won't have any increase in precipitation in the next century. The temperatures will increase 2-4 °C in the region in the next century according to RegCM3 regional climate model. Both plant belts and tree line will change under the current climate scenarios for the region. The influence of these changes on diversity in the region will be important and will vary according to site conditions.

Keywords: species, habitat, endemic, areas, plant

I. Introduction

Human activities have caused and will continue to cause a loss in biodiversity through land-use and land-cover changes; soil and water pollution and degradation (including desertification), and air pollution; diversion of water to intensively managed ecosystems and urban systems; habitat fragmentation; selective exploitation of species; the introduction of non-native species; and stratospheric ozone depletion.

The current rate of biodiversity loss is greater than the natural background rate of extinction [Anon., 2002; Green et al., 2003].

Changes in climate exert additional pressure and have already begun to affect biodiversity. The atmospheric concentrations of greenhouse gases have increased since the pre-industrial era due to human activities, primarily the combustion of fossil fuels and land-use and land-cover change. These and natural forces have contributed to changes in

the Earth's climate over the 20th century. For the wide range of Intergovernmental Panel on Climate Change (IPCC) emissions scenarios, the Earth's mean surface temperature is projected to warm 1.4 to 5.8°C by the end of the 21st century, with land areas warming more than the oceans, and the high latitudes warming more than the tropics. The associated sea-level rise is projected to be 0.09 to 0.88 m [Anon., 2002].

In general, precipitation is projected to increase in high-latitude and equatorial areas and decrease in the subtropics, with an increase in heavy precipitation events. Climate change is projected to affect individual organisms, populations, species distributions, and ecosystem composition and function both directly (e.g., through increases in temperature and changes in precipitation and in the case of marine and coastal ecosystems also changes in sea level and storm surges) and indirectly (e.g., through climate changing the intensity and frequency of disturbances such as wildfires) [Anon., 2002].

Turkey contains a great variety of natural habitats, ranging from Mediterranean, Aegean, and Black Sea beaches to towering coastal and interior mountains, from deeply incised valleys to expensive steppes, from fertile alluvial plains to arid, rocky hillslopes (Kaya and Raynal, 2001). The components of biodiversity are important to maintain for the welfare and sustainable development of Turkey. Turkey contains the wild relatives of many domesticated plants, which have economic importance for the world, thus forming one of the eight major gene centers on earth [Harlan, 1995]. For example, wild progenitors of such cultivated plants as chickpea, wheat, peach, lentil, almond and pistachio are native to Turkey.

Civilizations have exploited the natural resources of Turkey over many millennia. Today, because of rapid human population growth (about 2.5% per year) and associated intensive or unwise utilization of natural resources and habitats the biodiversity of Turkey is deteriorating. Diverse ecological conditions (e.g. great variation in topography

and land-forms) are responsible for the growth of more than 9.500 plant species and hundreds of plant communities in Turkey [Ekim et al., 2000].

Eastern Black Sea Region of Turkey is rich in biodiversity compared to other regions. The east-west oriented, parallel ranges of the Northern Anatolian Mountains run in the southern part of the Eastern Black Sea. These coastal mountain ranges are the broadest and the highest in their eastern section, attaining elevations of over 3000 m (the highest peak Kaçkar Mountain is 3937 m). Northern Anatolian mountains form a barrier between the Black Sea and inland part of Central Anatolia. The north-facing slopes of these mountains receive abundant precipitation. For this reason, the broad-leaved deciduous forests and coniferous forests composed of *Fagus orientalis*, *Picea orientalis*, *Castanea sativa*, *Alnus glutinosa* and *Tilia rubra* species are found on the north-facing slopes of the northern Anatolian mountains. But tectonic depressions produce semi-arid climatic conditions due to lee of the mountains. These areas are covered by generally xerophytic plant communities composed of some Mediterranean plant elements.

Global climate change is one of the major challenges that Eastern Black Sea Region will face in this century, as in the other parts of the Turkey and the world. Global change will affect the region's climate, land-use, forest productivity and stability, biodiversity, risks of biotic and abiotic disruptions

Main objective of this paper was to discuss the effects of climate change on biodiversity in the region based on existing literature. We tried to evaluate status of biodiversity in the region under the climate change scenarios.

II. Current Status of Biodiversity in the Region

The region is very rich in biodiversity. There are around 2500 plant species in the region and 386 of them are endemic. High mountain areas in Artvin, Rize and Trabzon are the places rich in endemism. Eight of the

endemics are in critically endangered list of IUCN while 55 are in endangered list in the region. Most of the critically endangered and endangered species were found in grasslands

and forest openings. The distribution of total Table1. The distribution of total numbers of plant species and endemics according to major cities in the Eastern Black Sea Region.

Table 1.
The region is one of the 200 ecologically important areas in the world

Plant species	Artvin	Rize	Gumushhane	Trabzon	Giresun
Total number of species	1219	747	894	457	301
Number of endemics	119	74	70	54	19

Numbers of plant species and endemics are shown in Table 1. The region is one of the 200 ecologically important areas in the world. Four of the important plant areas reside in the region. An important bird migrating route passes through the region. Distribution of threatened species according to cities are listed below [Ekim et al., 2000] (CR: critically endangered; EN: endangered; DD: data deficient):

1. **Artvin:** *Anthemis calcarea* var. *calcarea* (CR), *Centaurea leptophylla* (CR), *Hypericum fissurale* (CR), *Lathyrus woronowii* (CR), *Onosma circinnatum* (EN), *Symphytum savvalense* (EN), *Campanula choruhensis* (EN), *Campanula troegerae* (EN), *Silene scythicina* (EN), *Rhodothamnus sessilifolius* (EN), *Helichrysum artvinense* (EN), *Hieracium diaphanoidiceps* (EN), *Hieracium foliosissimum* (EN), *Hieracium radiatellum* (EN), *Clypeola raddeana* (EN), *Hypericum marginatum* (EN), *Crocus biflorus* subsp. *artvinensis* (EN), *Crocus biflorus* subsp. *fibroannulatus* (EN), *Stachys choruhensis* (EN), *Lilium carniolicum* subsp. *ponticum* var. *artvinense* (EN), *Ornithogalum byzantinum* var. *proliferum* (EN), *Orobancha armena* (EN), *Heracleum sphondylium* subsp. *artvinense* (EN), *Hieracium artvinense* (DD), *Hieracium cinereostriatum* (DD), *Hieracium debilescens* (DD), *Hieracium floccicomatum* (DD), *Hieracium subartvinense* (DD), *Hieracium subhastulatum* (DD), *Hieracium virosiforme* (DD), *Astragalus imbricatus* (DD), *Allium koenigianum* (DD), *Gagea tenuissima* (DD), *Verbascum artvinense* (DD), *Ferulago latiloba* (DD),

2. **Rize:** *Campanula latiloba* subsp. *rizeensis* (EN), *Silene scythicina* (EN), *Senecio*

ovatifolius (EN), *Blismus compressus* subsp. *subulifolia* (EN), *Onobrychis lasistanica* (EN), *Geranium davisianum* (EN), *Sorbus caucasica* var. *yaltirikii* (EN), *Alchemilla ancerensis* (EN), *Alchemilla cimilensis* (EN), *Alchemilla ciminensis* (EN), *Alchemilla hemsinica* (EN), *Alchemilla ikizdereensis* (EN), *Alchemilla kackarensis* (EN), *Salix rizeensis* (EN), *Angelica sylvestris* var. *stenoptera* (EN), *Symphyandra lazica* (DD), *Hieracium amblylepis* (DD), *Festuca paphlagonica* subsp. *villosula* (DD), *Ranunculus dissectus* subsp. *rigidulus* (DD), *Ornithogalum balansae* (DD),

3. **Gumushhane:** *Paracaryum erysimifolium* (EN), *Paracaryum leptophyllum* (EN), *Barbarea integrifolia* (EN), *Aethionema sintenisii* (EN), *Hesperis stellata* (EN), *Thlaspi sintenisii* (EN), *Vicia quadrijuga* (EN), *Elymus longearistatus* subsp. *sintenisii* (EN), *Erodium hendrikii* (EN), *Arenaria scariosa* (EN), *Onosma obtusifolium* (EN), *Galanthus koenianus* (EN), *Centaurea rhizocalathium* (DD), *Echinops sintenisii* (DD), *Hieracium mannagattae* (DD), *Hieracium subrosulatum* (DD), *Taraxacum bassarabicum* subsp. *gumusanicum* (DD),

4. **Trabzon:** *Symphytum sylvaticum* subsp. *sepulcrale* var. *hordorkopii* (EN), *Symphytum sylvaticum* subsp. *sylvaticum* (EN), *Sempervivum furseorum* (EN), *Erysimum deflexum* (EN), *Rhododendron ponticum* subsp. *ponticum* var. *heterophyllum* (EN), *Erodium absinthoides* subsp. *latifolium* (EN), *Festuca pontica* (EN), *Astragalus arakliensis* (EN), *Alchemilla trabzonica* (EN), *Salix rizeensis* (EN), *Salix trabzonica* (EN), *Verbascum varians* var. *trapezunticum* (EN), *Zelkova carpinifolia* subsp. *yomraensis* (EN), *Angelica sylvestris* var. *stenoptera* (EN),

Elymus longearistatus subsp. *sintenisii* (EN),

5. **Giresun:** *Micromeria fruticosa* subsp. *giresunica* (CR), *Doronicum tobeyi* (CR), *Hieracium tamderense* (EN), *Hieracium giresunense* (EN).

III. Climate change scenarios for the region

Analyzing the meteorological data belong to stations located in the Eastern Black Sea Region from 1951 to 2004, Dalfes et al. (2007) observed increases in winter and spring precipitations in Artvin, decrease in spring precipitation in Trabzon and decrease in mean annual temperature in Artvin. In the same report, future climate of the region has been predicted using RegCM3 regional climate model.

According to RegCM3 regional climate model, the temperatures will increase 2-4 °C in the region in the next century. Future climate scenarios predict 200-300 mm increases in precipitation in the eastern part of the region while the western part won't have any increase in precipitation in the next century.

IV. Influence of climate change on biodiversity in the region

Climate change will influence distribution, structure, stability and diversity of plant ecosystems in the region. With the influence of predicted changes, it is possible to observe 400-800 m upward shifts in the plant belts in the western part of the region and upward movement of treeline in the eastern part. The upward shift in the treeline will threaten the biodiversity of the alpine grassland areas. An important portion of these areas will be covered by spruce or pine forests. Sub-alpine forest areas don't support plant species as many as alpine grasslands support. According to Tüfekçioğlu et al. (2004), alpine grasslands support 550 plant species, while spruce forests support around 100 plant species.

Temperature increases in the region will put more stress on spruce trees and will probably increase the bark beetle attacks. Around 100 000 spruce trees have been killed by the bark beetle attacks in Hatilla National

Park, Artvin [Tüfekçioğlu et al., 2005, 2008]. This will influence the diversity of these forests. Insect-attacks regulated secondary succession will be more common in spruce ecosystems.

Fire could become an important threat in the western and inner parts of the region with the predicted climate change. Currently, fire is not a problem in oriental spruce ecosystems. Spruce ecosystems in our country have a humid climate in summer season. Therefore, it is unusual to see fire in them. However, fire is an important factor in maintaining structure, diversity and health of boreal spruce ecosystems. Influence of fire on biodiversity of the region will possibly be positive up to a certain level. It will be possible to see fire-induced secondary succession taken place in the western part of the region.

Replacement of some spruce and beech forests with the pine forests will increase species diversity in the region. Because spruce and beech are shade tolerant species, while pine is a shade intolerant species. Stands of shade intolerant species have more plant species in understory compared to shade tolerant stands.

V. Conclusions

Climate change will significantly influence distribution, diversity, structure and stability of the ecosystems in the Eastern Black Sea Region. According to RegCM3 regional climate model, the temperatures will increase 2-4 °C in the region in the next century. Future climate scenarios predict 200-300 mm increases in precipitation in the eastern part of the region while the western part won't have any increase in precipitation in the next century. The following measures need to be taken to protect the biodiversity and human health in the region in the future:

- Flooding and land-sliding events will possibly increase in the region. Emergency management center need to be established to help and warn people
- Forest fires will increase in the western part of the region. Fire observation

towers and fire fighters teams need to be established in these areas.

- Biodiversity in high mountain areas will decrease due to upward movement of treeline and effects of heavy grazing. Establishing small gaps in these newly forested areas will help to save biodiversity.
- Biodiversity in lowland areas will increase due to decrease in tea garden areas.
- Spruce forests in the western part will

mainly be replaced by the beech forests.

- Habitats of mountain grouse and goat will decrease significantly; threatening survival of these threatened species.
- Spruce bark beetle attack will kill more spruce trees and will be a serious problem for the spruce ecosystems. Appropriate measures need to be taken to prevent bark beetle outbreaks in the region.

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EFFECT OF NANOPARTICLES ON PHYSIOLOGICAL AND BIOCHEMICAL PARAMETERS OF CORN PLANTS CULTIVATED IN THE FIELD CONDITIONS

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Abstract. *The use of nanotechnology in agricultural practice has great potential to increase crop yields. The effects of nanoparticles on seed germination, growth stimulation, metabolic rate, biochemical and physiological processes have been studied in detail in a number of scientific studies. In this studies, it has been shown that the treatment seeds of corn by nanoparticles improved the physiological and biochemical parameters of plants under drought. The effect of nanoparticles Fe₂O₃, ZnO and TiO₂ (size = 18.05 nm) at concentration 1.0 ppm was investigated to improve drought tolerance. The leaves and stems of the seedlings of corn (Zea mays L.) in different stages of growing were used for assessing various physiological and biochemical traits. The middle portion of the leaf was used for chlorophyll composition and enzyme activity studies. In experiments, the effect of nanoparticles on the seed germination, enzyme guaiacol peroxidase (GPx) activity, chlorophyll content in the leaves were determined. The nanoparticles positively affected growth, chlorophyll contents and enzymatic antioxidants.*

Keywords: *nanoparticles; corn plants, plant seedlings; chlorophyll; enzyme activity*

1. INTRODUCTION

Drought stress is a global environmental problem and a serious threat to agricultural crops. During drought stress, very important physiological, biochemical, and morphological changes occur in plants, which ultimately reduce plant productivity, and in severe drought conditions, productivity is completely eliminated. In the fight against drought, the most modern methods of agronomy are used, the scientific achievements of plant physiology are applied, and the latest achievements of morphophysiological, biochemical and finally molecular biology, including genetic engineering, are used. New drought-resistant plant varieties are created through genetic research. Despite these achievements, the development of drought-resistant plants

remains relevant.

In this field, the nanotechnology that has emerged in recent decades has started to speak for itself. The application of nanotechnology to agriculture is in its infancy, even at the global level. Nanoscience, as a body of modern knowledge, accelerates the development of new methods of nanotechnological applications against biotic and abiotic stress responses. Nanomaterials, including nanoparticles, increase the hydraulic permeability and water absorption of the root system in plants exposed to drought, regulate oxidation-reduction, extinguish reactive oxygen species (ROS), participate in stress signaling and hormonal regulation, and increase stress resistance by creating differential abundance of proteins and carbohydrates. The interaction of nanoparticles

with the plant cell leads to the modification of the plant genome, which ultimately has a serious effect on the growth, development and productivity of the plant.

1.1. *Nanoparticles and plants.*

1. Nanoparticles (NPs) with sizes in the range of 1-100 nm induce various morphophysiological effects in plants, entering above-ground (cuticle, epidermis, stomata, damaged and infected parts) and below-ground organs (root tips, cortex, lateral root, wounds and other injuries). The effect of nanoparticles can be positive or negative depending on the type of plants, developmental stages, growth conditions, method of application, dose and duration of exposure [Rizwan, 2017]. NPs entering leaves through stomata are then transported to organs and tissues by phloem tubes as a result of the pressure and concentration difference between leaves and roots. Nanoparticles collected in plant organs have specific effects on antioxidant activity, macro and micro mineral nutrition, chlorophyll content in leaves, chloroplast morphology, photosynthesis and respiration processes, growth and productivity [Cinisli, et al., 2019]. NPs easily penetrate the cell wall, directly cross the cell membrane when they are smaller than 5 nm, and enter the cell by endocytosis when they are larger [Tripathi, et al., 2017]. Osmotic pressure and capillarity play an important role in the absorption of nanoparticles into the roots of plants, and they are transported from one cell to another through the pores of the cell wall through the apoplast pathway or after entering the cell through the symplastic pathway by plasmodesmata and accumulate in organs [Usman, et al., 2020]. Nanoparticles enter plant seeds through the parenchymatous intercellular spaces in their seed coat, and aquaporins in the seed coat regulate nanoparticle tissue uptake [Lee, et al., 2010; Abu-Hamdah, et al., 2004]. Recently, nano-fertilizer has started to be applied in agricultural practice. Nanofertilizers slowly meet the nutrient needs of plants using smaller amounts than traditional chemical fertilizers and reduce the environmental risks caused by fertilizers. Therefore, they suggest the widespread use of nanofertilizers and

nanopesticides to increase the productivity of plants by reducing the use of currently applied chemical fertilizers. There was already a need to replace pesticide and fertilizer applications with nanopesticides and nanofertilizers to take the development of agriculture to a new stage. The positive effect of nano-fertilizers on the development and metabolism of plants was related to their increase in the resistance of plants against biotic-abiotic stresses and diseases in changing climatic conditions, as well as their effect on enzymatic and hormonal levels [Cinisli, et al., 2019].

2. Nanopesticides such as Ag, Cu, SiO₂, ZnO, Fe₂O₃, Fe₃O₄ synthesized by physical, chemical or biological methods have a more effective impact compared to the traditional pesticides used. For this reason, the use of nanopesticides against plant pests and diseases is one of the urgent issues [Chhipa, 2017]. It was found that zinc oxide nanoparticles (ZnO) increased the germination percentage in maize plants, improved seedling growth, but significantly retarded root growth [Singh, et al., 2017]. In general, experiments show that as a result of the application of nanoparticles, seed germination, seedling growth and development, seedling vigor and emergence rate increase [Abbasi, 2021]. SiO₂ nanoparticles increase root and shoot length, wet and dry weight, amount of total phenols, soluble proteins, free amino acids, proline, antioxidants, activity of catalase, peroxidase and superoxide dismutase in plants, TiO₂ nanoparticles increase germination percentage, eliminate negative effects of drought stress, increases the amount of chlorophyll and carotenoids, accelerates growth, productivity, and increases the amount of gluten and starch in grain [Magdy, et al., 2016; Wang, et al., 2011]. Ag nanoparticles increase shoot length and chlorophyll content in *Brassica juncea* and *Sorghum bicolor* [Sharma, et al., 2012].

1.2. *Nanoparticles under drought conditions.*

3. As the abiotic stress drought significantly limits crop production. Experiments show that nanoparticle application is effective in mitigating the influence of drought on plants due to their many positive effects such as

increasing antioxidant enzyme activity, improving phytohormone levels and effecting on physiological properties. It was found that during application of analcite nanoparticles to soil in hot and dry conditions to promote germination and plant growth in wheat [Hossain, et al., 2021]. In the arid conditions application of ZnO nanoparticles to soybean plants increased the percentage of germination in seeds [Sedghi, et al., 2013]. Under drought stress by application of Cu and Zn nanoparticles to wheat plants increased relative moisture content and antioxidant enzyme activity, stabilized the photosynthetic pigment in leaves, decreased thiobarbituric acid, reagent accumulation, and alleviated the effects of stress [Taran, et al., 2017]. Under drought stress, SiO₂ nanoparticle application reduced superoxide radical formation and membrane damage but increased shoot length and relative water content in barley. Yıldız, Ş. And Jaberzadeh et al. found out that foliar application of TiO₂ nanoparticles to wheat in arid conditions was effective in overcoming the yield reduction caused by drought stress [Yıldız, et al., 2018; Jaberzadeh, et al., 2013]. Application of CuO nanoparticles to maize under arid conditions increased leaf water content, plant biomass, anthocyanin, chlorophyll and carotenoid content [Van Nguyen, et al., 2021]. In the experiments of Ashkavand et al. has been show that the application of SiO₂ nanoparticles to hawthorn grown under drought stress conditions results a decrease in photosynthesis and stomatal conductivity in plants [Ashkavand, et al., 2015]. But the application of silicon nanoparticles improves the effects of drought stress in bananas [Mahmoud, et al., 2020]. In moderate drought conditions, foliar application of silicon nanoparticles to coriander resulted in optimum antioxidant capacity and essential oil yield. Afshari M. and Shalan emphasized that the application of silicon nanoparticles to the soil decreased the harmful effects of drought by increasing the relative moisture content of the chickpea [Afshari, et al., 2021; Shalan, et al., 2016]. The foliar application of SiO₂ and TiO₂ nanoparticles reduced their negative effects on

cotton plants in arid conditions [Güney, et al., 2002]. Drought stress resulted in greater enhancement of the negative effect of Cd in wheat, while the application of ZnO NPs ameliorated both Cd and drought stress [Khan, et al., 2019]. Drought stress adversely affects the germination and growth of lentil (*Lens culinaris* Medic) seeds. To eliminate this effect, they conducted experiments using silver nanoparticles. The lentil seeds were drought induced in the variants with soil water potential of -0.4, -0.6, -0.9 and -1.1 Mpa. Concentrations of 0, 10, 20, 30 and 40 µg mL⁻¹ of silver nanoparticles were tested. Characteristics such as germination percentage, germination rate, length of sprouts (the length of shoot and root together), wet and dry weight of sprouts, germination period were measured. The results of these experiments showed that different concentrations of PEG and silver nanoparticles had a significant effect on germination rate and germination percentage, root length, root wet and dry weight. Silver nanoparticles at a concentration of 10 µg mL⁻¹ increased the percentage and rate of germination in the control variant. Root length and wet weight were greater in seedlings exposed to drought stress. The results of these experiments showed that the use of silver nanoparticles increased the germination percentage of lentil seeds and the growth rate of seedlings under drought conditions [Seyed Saeid, 2016].

2. MATERIALS AND METHODS

2.1. Material.

Adana 80 variety of corn was used as an experimental object. This corn variety was created by scientists of Ganja Agrarian University, grain yield is 10-12 s/ha, green mass productivity is 60-80 s/ha.

2.2. Nanoparticles.

The nanoparticles (Fe₂O₃, ZnO and TiO₂) in powder form were purchased from Sky Spring Nanomaterials, Inc (USA). The characteristics of the particles were as follows. Average particle size: 18 nm, purity: 99.9% and surface area > 80 (m²/g) as reported by the commercial agent. Maize seeds were dusted with nanoparticle powder before sowing. For this, 1 mg of each

nanoparticle was added to a 50 ml glass for 10 seeds, and the seeds were processed in a shake for 10 minutes.

2.3. Field experiments and site description

The field experiments were conducted at the experiment area of the Chloroplast Photochemistry laboratory of the Institute of Molecular Biology and Biotechnology of ANAS. The soil of experimental locality were brown forest soils where intensive soil-cultivation enables annual maize rotation. Experimental plots were presented in an area of 2 and 2 m² with two repetitions of each treatment. Two experimental options (control - irrigated site and site created by drought) were installed randomly located, perpendicularly separated blocks (Figure. 1). The experimental plot prior to

our experiment was used for growing wheat in the season. The usual plowing procedure was carried out and fertilizer was applied to the soil only before sowing, during the growing season fertilizer was not applied. Each blocks that received different irrigation treatments. For the irrigation was used tap water. Both blocks from planting to the end of the 4th week was irrigated. Irrigation was thereafter discontinued in the test block. At this time, the control block was watered 2 times a week, and the test block was watered every 2 weeks. The following quantitative plant parameters were established: the number of plants, plant height and seed heads were counted manually. Plant height and seed head length were determined in centimeters by ruler.

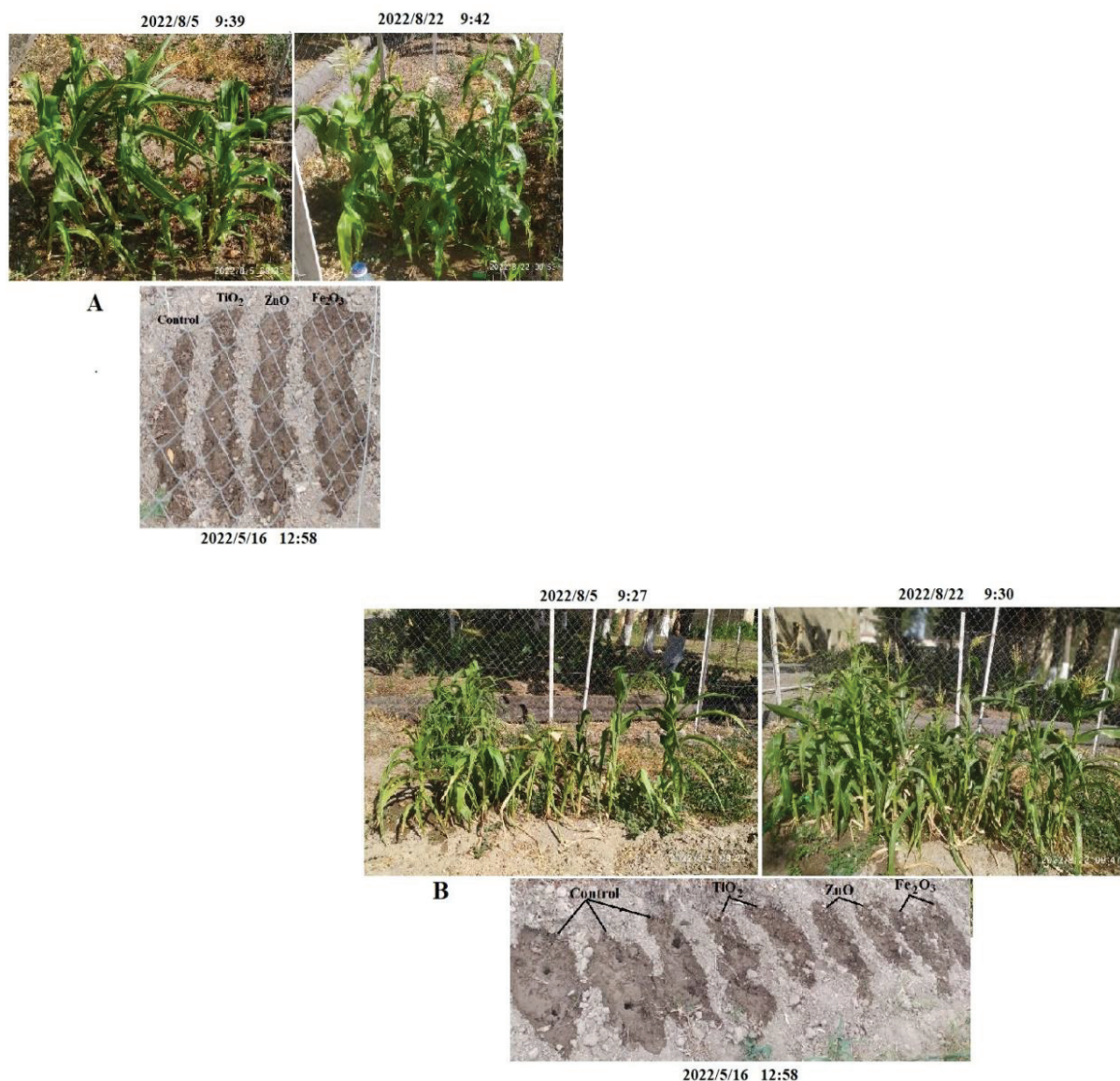


Fig. 1. Experimental plan visualization. **A-** irrigated site, **B-** site created by drought

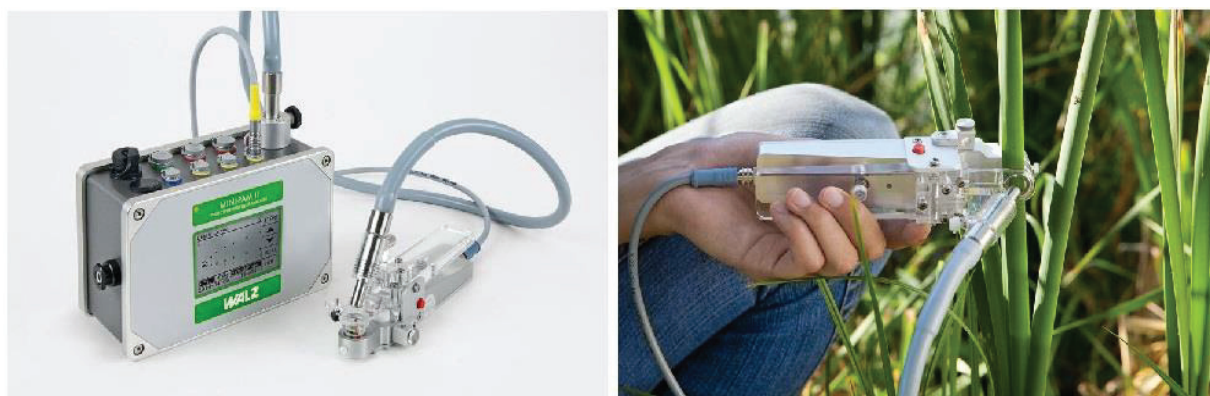


Fig. 2. The Photosynthesis Yield Analyzer MINI-PAM

2.4 Determining the activity of photosystem II and the enzyme.

The activity of photosystem II was determined with exceptional sensitivity and reproducibility the Photosynthesis Yield analyzer MINI-PAM (Germany). It is the reliable determination of the YIELD-parameter $\Delta F/F_m$ (Genty-parameter).

Enzyme activity was measured by standard biochemical methods. Peroxidase activities were measured as oxidation of Guaiacol (2-methoxyphenol) (21.5 mm, $\epsilon = 26.6 \text{ mm}^{-1} \text{ cm}^{-1}$) in the presence of 0.3% H_2O_2 within 2 min. In the presence of the enzyme, the peroxide is rapidly converted to water and oxygen, and the oxygen reacts with the guaiacol to form a brown product. As a result, guaiacol is oxidized. Brown can be measured with a spectrophotometer. Thus, the oxidation state of guaiacol correlates with the amount of the enzyme. Phosphate buffer (pH 6.7), 10^{-3}M solutions of MgSO_4 and 21.5 mM guaiacol were used to measure the activity of the guaiacol peroxidase enzyme by spectroscopic method. For the observe the catalyzed reaction of H_2O_2 and O_2 by peroxidase enzyme have been used at the stage of five-leaf corn, 25 ± 0.01 mg of leaves were taken from each variant, washed thoroughly in distilled water and then carefully ground in a mortar. The resulting homogenate were dissolved in a 50 ml flask in chilled phosphate buffer (5 ml). The extract were precipitated in a centrifuge (9000 rpm) for 10 minutes. Filled the test bath with 1 ml MgSO_4 , 2 ml phosphate buffer, 0.1 ml filtrate, and 21.5

mM guaiacol. Another bath (control) was filled with the same amount of these components, but with the addition of ice, 2 ml of H_2O instead of guaiacol. At the stage of five-leaf corn, 25 ± 0.01 mg of leaves were taken from each variant, washed thoroughly in distilled water and then carefully ground in a mortar. The resulting homogenate were dissolved in a 50 ml flask in chilled phosphate buffer (5 ml). The extract were precipitated in a centrifuge (9000 rpm) for 10 minutes. Filled the test bath with 1 ml MgSO_4 , 2 ml phosphate buffer, 0.1 ml filtrate, and 21.5 mM guaiacol. Another bath (control) was filled with the same amount of these components, but with the addition of ice, 0.7 ml of H_2O instead of guaiacol. The meter assumes a zero home position for each bath. The stopwatch is activated at the start of the measurement. The first measurement is taken after 30 seconds, then the measurement is taken every 5 sec and lasts 5-6 minutes. The enzyme activity (APO) were determined by the following formula:

$$\text{APO} = \text{DN}/\text{m.V}$$

where that, $D_{440} = (D_{440}^2 - D_{440}^1) \cdot (t_2 - t_1)$,

$$N = V_{\text{flask}}/V_{\text{extract}}$$

D_1 is the optical density of the solution at the beginning of the experiment (during the first measurement), D_2 is the optical density of the solution at the end of the experiment, t_1 and t_2 are the start and end times of the experiment. is the mass of the sample (mg), V_{extract} is the mass of the enzyme extract (ml), V_{flask} required volume (ml) [Ermakov, et al., 1987].

3. RESULTS

3.1. Physiological characteristics

In order to show the negative impact of water stress and the impact of nanoparticles under drought conditions, it is necessary to measure physiological signs. This is very important because such traits are considered to be a real indicator of the health and productivity of plants at different stages. Drought stress brings about depletion in plant growth rate, stomatal movements, leaf

expansion, and stem elongation. Furthermore, it changes several physiological processes governing plant growth and productivity. Drought significantly ($P \leq 0.01$) reduced the chlorophyll index (8%), photosystem (PS) II quantum yield (12%), stomatal conductance (20%), and carbon assimilation rate (23%) compared to the irrigated control [Djanaguiraman, et al., 2018].

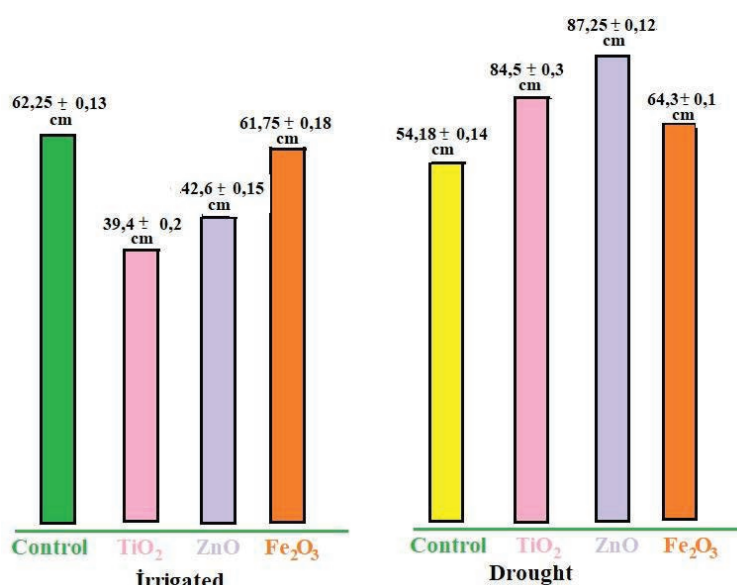


Fig. 3. Effects of nanoparticles on maize plant height under irrigated and drought conditions

As mentioned, drought was created in the second block after 4 weeks of sowing the seeds. After that, the growth rate of the plants cultivated in the irrigated field and the plants cultivated in the drought were monitored. Observations have shown that drought slows down the development of plants. After 80 days, plant height was measured in both areas. The results of these measurements are given in Figure 3. It was found that nanoparticles negatively affect the development of plants growing in the irrigated area. Of the nanoparticles, TiO₂ has a greater effect than the others. However, nanoparticles had a stimulating effect on plants growing in arid areas. ZnO was more affected than nanoparticles. Thus, plants whose seeds were treated with TiO₂ nanoparticles grew more intensively regardless of drought stress and their height

increased by 1.5 times compared to the control. Height increase was 1.6 times greater than the effect of ZnO nanoparticles, and 1.17 times greater than the effect of Fe₂O₃ nanoparticles.

$\Delta F/F_m$ directly measures the quantum yield of PSII electron transfer and is an extremely useful parameter in the field. $\Delta F/F_m$ parameter was determined on the 40th day of corn development. Samples (5 cm²) were taken from the leaves of both sites, irrigated and drought-exposed plants, and measured with a PAM device after keeping them in the dark for 20 minutes. The results of measurements are given in tables 1 and 2. The results revealed that nanoparticles do not seriously affect the productivity of photosynthesis in corn plants cultivated under irrigation conditions. Only slightly reduced ZnO nanoparticles. So, if the value of Y was

0.973 in the control variant, it was 0.910 due to the effect of ZnO (Table 1). The value of Y in corn plants exposed to drought does not differ significantly from the prices in the

irrigated variant. Nanoparticles do not significantly affect the value of Y in the drought scenario (Table 2).

Table 1.

The effect of nanoparticles on the Photosynthesis Yield in the leaves of corn plants grown under irrigation conditions

	F_0	F_m	$Y = \frac{F_m - F_0}{F_m}$
Control	18 ± 2	689 ± 3	$0,973 \pm 0,005$
TiO ₂	47 ± 1	749 ± 5	$0,937 \pm 0,008$
ZnO	78 ± 3	870 ± 2	$0,910 \pm 0,003$
Fe ₂ O ₃	67 ± 2	844 ± 4	$0,973 \pm 0,005$

Table 2.

The effect of nanoparticles on the Photosynthesis Yield in the leaves of corn plants grown under drought conditions

	F_0	F_m	$Y = \frac{F_m - F_0}{F_m}$
Control	22 ± 4	679 ± 5	$0,968 \pm 0,008$
TiO ₂	49 ± 3	760 ± 4	$0,936 \pm 0,006$
ZnO	76 ± 5	874 ± 6	$0,913 \pm 0,007$
Fe ₂ O ₃	72 ± 3	842 ± 7	$0,914 \pm 0,006$

3.2. Effect of nanoparticles on Antioxidant Enzyme Activities

Application of nanoparticles significantly improved antioxidant enzyme activity in drought-stressed maize plants as compared to untreated seeds. Experiments show that nanoparticles cause the increase of reactive oxygen species (ROS) in plants as abiotic stress and consequently the activation of antioxidant enzymes. However, the effect of nanoparticles depends on their application method and concentration. Low concentrations of nanoparticles in plants lead to reduced antioxidant activity due to low oxidative stress. However, when oxidative stress is high, the activity of the enzyme in the antioxidant defense system increases. In other words, the effect of nanoparticles is similar to the effect of stress factors such as drought and salinity. Thus, in plants, antioxidant enzymes such as Catalase (CAT),

Ascorbate Peroxidase (APX), Guaiacol Peroxidase (GPX) and Glutathione Reductase (GR) functions to interrupt the cascades of uncontrolled oxidation in some organelles [Roychoudhury & Tripathi, 2019].

In our experiments, nanoparticles were applied in a specific way. So, corn seeds are soaked and sprinkled with nanoparticle dust. Therefore, their influence can produce different results. The results of the experiments show that GPX activity decreased as a result of the effect of nanoparticles under irrigation conditions. The reduction was greater in TiO₂ nanoparticles than in ZNO and Fe nanoparticles. GPX activity significantly increased in the drought variant. It was 20-25% more than the activity under irrigation conditions. Nanoparticles also reduced GPX activity in the drought variant. In this case, the effect of ZnO nanoparticle was greater. The results of the experiments are given in Figure 4.

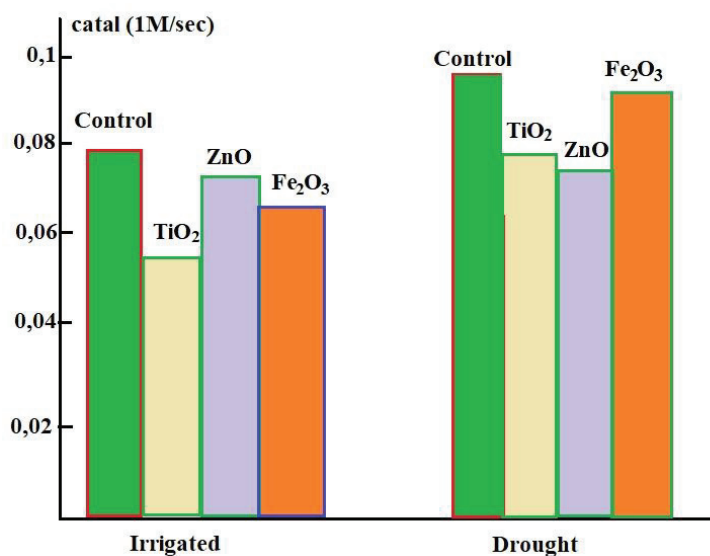


Fig. 4. Effects of nanoparticles on the activity of Guaiacol peroxidase (GPX) ferment in maize plant under irrigated and drought conditions

4. CONCLUSION

Drought stress is known to severely inhibit plant growth and development at all stages of plant development from germination to maturity. Studies show that drought reduces the plant's height, biomass, root length, number of leaves, water capacity, seriously affects stomatal activity, photosynthesis and antioxidant system. Extensive physiological, biochemical and genetic studies have been conducted in the direction of increasing drought resistance in plants. The experiments confirmed that drought ($P \leq 0.01$) reduced chlorophyll index (8%), photosystem (PS) II quantum yield (12%), stomatal conductance (20%) and carbon assimilation rate (23%) compared to the irrigated control [Djanaguiraman, et al., 2018]. The reasons for the effects of drought on such important physiological processes have been clarified by a number of experiments. It was found that the reduction of chlorophyll pigment in leaves due to the effect of drought is the decrease in the production of chlorophyllase, peroxidase enzymes and phenolic components. In plants under drought stress, the relative water capacity of leaves decreases, water retention becomes difficult, turgor pressure weakens, and leaf area decreases. In addition, exposure of plants to various biotic or abiotic stresses

leads to the generation of Reactive Oxygen Species (ROS), which are considered strong oxidants and potentially harmful substances for cells. Thus, plants protect their cellular systems from the cytotoxic effects of reactive oxygen species accumulated during drought using antioxidant enzymes such as superoxide dismutase, glutathione peroxidase, and catalase. Superoxide dismutase neutralizes superoxide anion free radicals (O_2^-) by forming H_2O_2 , which can then be eliminated by catalase and peroxidase [Hasheminasab, et al., 2012].

Experiments show that the drought resistance of plants can be increased by applying nanoparticles. For example, in drought-stressed plants, application of SiO_2 NPs achieves higher SOD activity, which increases the efficiency of the antioxidant system protecting drought-stressed plants from oxidative damage. Therefore, SiO_2 NPs partially compensate the negative effect of drought on plants by increasing the activity of SOD, glutathione reductase [Gong, et al., 2005.] and catalase [Zarafshar, et al., 2015] enzymes. On the other hand, protein accumulation alters the response to drought stress. Drought stress reduces starch deposition in wheat grain, resulting in increased grain size. protein content [Gooding, et al., 2003]. Some researchers have reported

that drought stress increases total protein content in rice [Fofana, et al., 2010].

Thus, nanoparticles increase root hydraulic conductivity, water absorption in plants, induce differential abundance of proteins involved in oxidation-reduction, ROS detoxification, stress signaling, and hormonal pathways, thus increasing plant stress tolerance. Nanoparticles induce gene expression and modification of biological pathways in plant cells and consequently affect plant growth and development. In our experiments application of nanoparticles significantly improved antioxidant enzyme activity in drought-stressed maize plants as compared to untreated seeds. Experiments show that nanoparticles cause the increase of reactive oxygen species (ROS) in plants as

abiotic stress and consequently the activation of antioxidant enzymes. However, the effect of nanoparticles depends on their application method and concentration. Low concentrations of nanoparticles in plants lead to reduced antioxidant activity due to low oxidative stress. However, when oxidative stress is high, the activity of the enzyme in the antioxidant defense system increases. In other words, the effect of nanoparticles is similar to the effect of stress factors such as drought and salinity. Thus, in plants, antioxidant enzymes such as Catalase (CAT), Ascorbate Peroxidase (APX), Guaiacol Peroxidase (GPX) and Glutathione Reductase (GR) functions to interrupt the cascades of uncontrolled oxidation in some organelles [Roychoudhury & Tripathi, 2019].

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NEW PHARMACEUTICAL PREPARATIONS THE POTENT MEDICINAL HERB OF
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Abstract. *The present article is an increasing demand for herbal medicines, Pharmaceuticals products of Licorice. Research of scientists of the Azerbaijan Medical University, the limphotrop, antiviral, anticoagulant properties of Licorice drugs, reducing blood clotting and restoring the activity of the immune system have been proven in the treatment of bronchopulmonary diseases, COVID-19. Medicines developed by Azerbaijani scientists based on Licorice, a natural raw material with lymphotropic and antiviral action, prevent the virus from binding to the host cell membrane, inhibit the replication of the virus that has already entered the body, thus preventing the development and spread of the disease. The research proposed by our laboratories in this area has helped save the lives of thousands of people. The goal of this work is to disclose the importance and usefulness of Licorice based medicinal syrups in the treatment of the Covid-19 infection. It is good that medicinal syrups produced at "Biyon" Industrial Park, such as "Biyon" Syrup, Biyan "Immunovit" Syrup; Biyan "Broncho" Syrup, Biyan "Gripson" Syrup proved itself in the Covid-19 pandemic. Many patients recovered in Covid-19 pandemic by taking only these drugs. In addition, the following therapeutic syrups helped to eliminate the complications of COVID-19: Biyan "Sed"; Biyan "Hem"; "Biyon" Syrup:*

Keywords: *potent medicinal herb – Glycyrrhiza glabra L. (F.), pharmaceutical products, limphotropic activity, "Licorice" Industrial Park Azerbaijan Republic, medical sirops, Covid -19.*

Introduction. Our Republic is located on the southwestern coast of the Caspian Sea and has a very favorable climatic conditions (of the 12 climate types existing on the world, our homeland is endowed with 9 climate types), so there are numerous opportunities to use natural resources, including medicinal plants, products of animal and mineral origin for the needs National economy.

Protecting the health of the population is always in the attention of our State and Health workers. Among his achievements, the most important is the application of high-quality pharmaceutical products in the prevention and treatment of various diseases.

The world's pharmaceutical industry is developing rapidly, and the range of drugs produced is increasing every year. However, as a rule, chemical drugs cause side effects and according to the research of scientists, it is completely possible to treat many diseases with medicinal plants or plant-based drugs without using chemical drugs [Valiyeva, 2012; Valiyeva, et al., 2012]. The flora of Azerbaijan is rich and colorful. The vegetation of our republic includes 4100 different types of plants: 930 general and 125 families. It is important to note that 64% of the plants of the Caucasus are in Azerbaijan [Flora Azerbaijan 1950-1961; Gurbanov 2009].

According to the letter No. 2/483 dated May 15, 2012 of the head of the administration of the President of the Republic of Azerbaijan, the business we offer is about the effective use of the natural resources of Azerbaijan, including the rich flora and fauna, and the organization of the production of national pharmaceutical products.

Article 23.3.1 of Article 4 of the Law of the Republic of Azerbaijan on Science (June 14, 2016) states that "Clusters, special zones, creation of technopolises, technoparks" based on the integration of science, education and economy arising from this article, the organization of new production areas and technoparks is the duty of every person who loves his Motherland and Country.

Discussion. During the definite period of time (1985-2022) we had learned 326 medical plant row, found 110 plants the capacity of ones which effect on the hemocoagulation process (coagulation, anticoagulation, fibrinolise) in vitro.

The experiments holding in vitro & in vivo on the intact animals allowed us to present 46 effective medical objects that are able to be sources for obtaining preparations with hemo- & lymphocoagulate ability [Velieva, 1998].

There had been a comparative qualitative phytochemical analysis of 12 perspective medical plants; their lymphoactivity was proved.

We found out that *Glycyrrhiza glabra* L.

(F.) is the most perspective medical plant with lymphostimulate activity. Licorice ranks first among flowering plants in terms of swan properties and currently has 15862 patents [4,20,21].

The word *Glycyrrhiza* is derived from the Greek term *glykos* (meaning sweet) and *rhiza* (meaning root). *Glycyrrhiza glabra* Linn, commonly known as 'liquorice' and 'sweet wood' belongs to Leguminosae family.

Scientific Classification

Kingdom: Plantae

Family: Leguminosae

Division: Angiospermae

Genus: *Glycyrrhiza*

Class: Dicotyledoneae

Species: *G. glabra* Linn.

Order: Rosales

The *Licorice* – based drugs are termed differently in various countries: "Biyar" (Azerbaijan); "Liquiriciae" (Latin); "Glycyrrhiza" (Greek); "Licorice" (English); "Sussholz" (German); Liquiriciae (French); Lucretius (Ukraine); Lokritsiya (Bulgarian); "Gantcao" (Chinese); Gamco (Korean); "Maduka" (Mongolian); "Dzir-tribili" (Georgian). Vernacular names for liquorice are Jeshtamadh (Marathi), Jothi-madh (Hindi), Yashtimadhu, Madhuka (Sanskrit), Jashtimadhu, Jaishbomodhu (Bengali), Atimadhuram, Yashtimadhukam (Telugu), Jethimadhu (Gujarati) and Atimadhuram (Tamil) et also.



Figure 1. *Glycyrrhiza glabra* plant.



Figure 2. *Glycyrrhiza glabra* root.

The content of *Glycyrrhiza* of vegetate in Azerbaijan 6 species Licorice this is higher than in the other species distributed in the world [Ammosov, et al., 2022; Valiyeva, et al., 2021].

1) Rough liquorice (*Glycyrrhiza aspera* Pall.); 2) Sweet liquorice (*G. glabra* L.); 3) Prickly liquorice (*G. echinata* L.); 4) Ferrous liquorice (*G. glandulifera* Waldst. et Kit); 5) Stiff-haired liquorice (*G. hirsuta* L. emend. Pall.); 6) Fetid liquorice (*G. foetidissima* Taush).

Along with glycyrrhizic acid, licorice contains saponins, flavonoids, steroids, essential oils, vitamins, organic acids, trace elements, resins, phytosterols, lipids, pectins, carbohydrates, etc. - it is very rich in nutrients. Modern methods have made it possible to obtain more than 200 biologically active substances from licorice, and the most useful of these substances is glycyrrhizic acid. Glycyrrhizic acid has become the main object of research in various fields of medicine due to its wide range of biological activity.

We worked out the rational methods of the modifications for the obtaining of the pharmacologically active components from *Glycyrrhiza glabra* (F.). As well as the chemical contain was learned. We obtained 120 pharmacoterapeutic preparations of *Glycyrrhiza glabra* F. They included in the comparative fitotechnology and pharmacological experiments, 65 patents and 42 technical specifications were obtained [Valiyeva, et al., 2022].

Materials and methods.

Liquorice is perennial medicinal herb that belongs to leguminous plants. The height of the herb is 60-100 cm and the inflorescence is pale violet.

Due to the ever-growing sprouts of liquorice roots during 3-4 years, they occupy scores of square metre areas and extend up to 2-7 m depth beneath the soil.

In Azerbaijan, there are 6 kinds of liquorice: in the lowlands of Kur-Araz (the Mughan Plain, Kurdemir, Ujar and Berde regions) and Samur-Devechi, in the Caspian Plains, in the Greater Caucasus (in the north-

eastern part, the Alazan-Eyrichay valley, Gobustan, Absheron), the Minor Caucasus (in the central and southern parts) and in the plains of Nakhchivan.

Ingredients: Liquorice contains more than 200 various bioactive compounds - glycyrrhizic acid belonging to triterpene - saponins, flavonoids, minerals and steroids. **Effects:** It has limphotropic, anti-inflammatory, antiallergic, antiviral, wound-healing, immunodulatory, expectorant, mucolytic, antidoting, antioxidative, anticarcinogenic, hepatoprotective, adaptogenic, hypocoagulating properties and antispasmodic effects for bronchial muscles.

Althaea officinalis L. **Ingredients:** 40 percent of mucous and 11 percent of pectin. **Effects:** It protects the mucous membranes against irritation, reducing the inflammatory plaque, boosts healing process, and acts as expectorant and mucolytic. It is effective against cough.



Pimpinella anisum L. **Ingredients:** Essential oils. **Effects:** It is used as expectorant, anti-cough, mucolytic, and immunostimulant remedy. It helps the digestion process by stimulating motor and secretory functions of the gastrointestinal tract, and reduces flatulence.



Inula helenium L. Ingredients: Cesciviterpenoides, cumarine, flavonoids, essential oils, vitamins C and E, steroid, korotines, wax and other dietary supplements. **Effects:** It is used as anti-cough, expectorant, antipyretic, anti-inflammatory, immunostimulant remedy.



Echinacea purpurea (L.) Moench. Ingredients: Phenol acid, insulin, essential oils, laevulose, oxidase and peroxidase enzymes. **Effects:** It has anti-inflammatory, immunostimulating properties, and it improves metabolism, it is effective against flu and common cold, infectious and inflammatory diseases of the nasal-mouth area and oral cavity, recurrent infectious diseases of respiratory and urinary tracts, and during long-term antibiotic treatment of chronic infectious and inflammatory diseases.



Rosa canina L. Ingredients: Vitamins B, C, E, K, P (rutin) and carotene. **Effects:** It has anti-inflammatory, diuretic and choleretic properties. It also boosts the gastro-intestinal tract functions. It delays the process of sedimentation in the walls of blood vessels, lowers cholesterol in blood and fights against atherosclerosis. It boosts the immune system, improves blood clotting and the absorption of vitamin C.



Silybum marianum (L.) Gaertn. Ingredients: Essential oils, alkaloids, saponins, flavonoids, vitamin K, wax, caronitoids and silymarine. **Effects:** It is effective against chronic poisoning, fatty liver, Hepatitis, and liver cirrhosis caused by alcohol drugs, toxins, radiation, and compromised immunity.



Trifolium pratense L. Ingredients: Organic acids, essential oils, wax, carotenes, isotrifolin and trifolin glycosides, alkaloids, tannins, flavonols, different vitamins and salts. **Effects:** It has positive effects for chronic cough, bronchial asthma, anemia, scrofula, gastritis, colitis, cholecystitis, hemostatic kidney stones, and diathesis and is also expectorant, antiseptic, astringent and diuretic remedy.



Thymus vulgaris L. Ingredients: Proteins, essential oils (carvone, limonene, carvacrol), flavonoids, triterpene combinations, Vit C. **Effects:** Thyme is very effective against different skin diseases, headache, stomachache, diseases of joints; insomnia, depression, hair loss, excessive oily skin, acne problems, respiratory tract diseases; it improves memory and increases attention.



Tilia cordata Mill. Ingredients: Tannins, essential oils, saponins, flavonoids, glucose, coumarin, and carotene. **Effects:** It has diaphoretic, choleric, sedative, and anti-inflammatory properties. It has astringent effect for increasing gastric juice secretion. The different parts of the herb are used for food poisoning, stomach diseases, diarrhea, tuberculosis, and eczema.



Punica granatum L. Ingredients: Organic acids, cellulose, tannins, and vitamins C, B₆, B₁₂, minerals and microelements Fe, K, Na, Ca, Mg, Mn, Al, P, and Cu. **Effects:** It increases hemoglobin level in blood, it is rich with antioxidants. Pomegranate fruit and peel are used as astringent, against helminths, and for diarrhea. It helps digestion, improves metabolism and boosts the immunity.



Berberis vulgaris L. Ingredients: Berberine alkaloid, glucose, fructose, pectin,

and vitamin C. **Effects:** It helps contraction of uterus, and increases blood clotting, has strong anti-inflammatory, antibacterial, choleric and antispasmodic properties, it is used for diarrhea, liver and gall bladder illnesses, against anemia and fever.



Melissa officinalis L. Ingredients:

Flavonoids, essential oils, vitamins B₁, B₂, C, and carotene. **Effects:** Oil of lemon balm is used as a strong calming remedy. It reduces heart palpitations, effective against heartaches, and lowers blood pressure, increases appetite, improves gastro-intestinal tract function, has slight purgative effect, reduces flatulence, takes nausea and vomiting away, and has diaphoretic properties, reduces pain and spasm, soothes the nerves, regulates menstrual disorder (hypomenorrhea), and is effective against uterus diseases.



Passiflora incarnata L. Ingredients:

Alkaloids, flavonoids and saponins. **Effects:** It has sedative effect for sleeping disorders, nervousness, and nerve irritations. It is

effective against headaches, has positive properties for asthma attacks, spasm, and hypertension due to nervous conditions.



Humulus lupulus L. Ingredients:

Vitamins B₁, B₃, C, essential oils, wax and tannins. **Effects:** It has soothing effects for the nervous system, used as sedative and painkiller in neuralgia and radiculitis, and reduces the spasm of the coronary artery of the heart; and as a bitter substance increases the secretion of gastric juice, boosts appetite and has bacteriostatic properties.



Mentha piperita L. Ingredients:

Essential oils, flavonoids, tanning agents and menthol. **Effects:** Mint has anti-spasmodic, pain-killing, and antiseptic properties. It is widely used in stenocardia, blood provision disorder of the heart, and in functional disorders of liver, gall bladder, and gastrointestinal tract. Mint oil improves intestinal motility, has antiseptic effect, and consequently reduces heartburn in gastro-intestinal tract.



Matricaria chamomilla L. Ingredients: Vitamins B₄, C, choline, carotene, essential oils, flavonoids and organic acids. **Effects:** It has anti-inflammatory, choleric, antibacterial effects; soothes pain, and is effective against burns. It relaxes the muscles, and relieves spasm of the abdominal organs.



Results and discussion. Licorice is a national treasure of Azerbaijan, since the species growing in our country are distinguished by a high content of glycyrrhizic acid (up to 24%). which makes them indispensable in the fight against viral infections. The COVID-19 pandemic shocked the whole world, claiming hundreds of thousands lives, since traditional medicines used in the fight against it. Amid which antibiotics accounted for a large percentage, were ineffective. Later it turned out that the use of antibiotics led to a deterioration in the patients' condition and an increase in mortality in the population. All the errors of medicine have been the result of a narrow

approach to the problem and a lack of recognition by some doctors and researchers of the value of herbal medicines. Because of glycyrrhizin and glycyrrhizic acid, the main ingredient of licorice root, is effective in the treatment of SARS (severe acute respiratory syndrome), herpes. AIDS, hepatitis, influenza, encephalitis and pneumonia, as well as in infections caused by respiratory syncytial virus, arboviruses, and viruses of vesicular stomatitis. Since glycyrrhizic acid and glycyram are safe and effective against SARS, scientists hope that these natural substances can become an important tool against COVID-19.

The rich ingredients of l.r make it possible use them not only in medicine, but also in different fields of industry, in foodstuff industry, in the production of construction materials, cosmetology.

As a guide to action in October 2012, the national LLC "Products Licorice" - "Biyon Products" was created, which is engaged in the development of pharmaceutical products based on licorice, the production of technical, food and pharmaceutical products of licorice and their sale. To this end, Biyon Products LLC purchased a land area of 1039 hectares in the Agdash region and created a plantation of naked licorice - *Glycyrrhiza glabra* L. on 1000 hectares, and also built on an area of 23 hectares the largest National Industrial Park "Licorice", including the Plant for the procurement, processing of licorice and the production of medicinal products on 11-12 hectares of land for the receipt of raw materials. Plantation - 937 Ha: Liquorice Procurement and Processing Factory-6480 m²; reception point (scales room) - 18,2 m². Procurement Point: area with open side surface - 2754 m²; covered area - 2346 m². Plant Extract and Syrup Factory - 1946 m²; Laboratories: chemical - 73,2 m²; microbiological - 35,4 m².

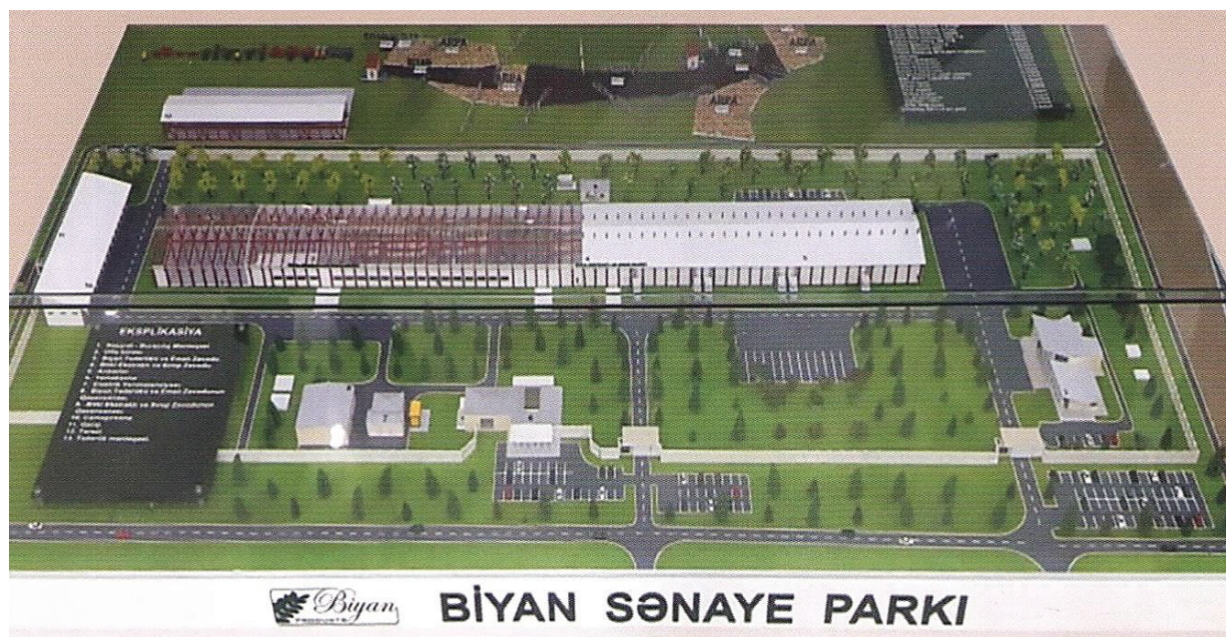


Fig. 2. Liquorice Industrial Park.

To produce high level dietary supplements from the ecologically pure plants cultivated in our soils and to promote Azerbaijan to international arena by representing the Azerbaijani brand in the world market.

Liquorice Procurement and Processing Factory. The factory operates under ISO and GMP standards. Total area: 6480 m². Capacity: 2300 kg/h. Equipment: Bigtem company (Turkey).



Fig. 3. Production area of the Liquorice Procurement and Processing Factory.



Fig. 4. Production area of the Liquorice Procurement and Processing Factory.

Plant extract and syrup factory. The Factory operates under ISO and GMP standards. Total area: 1946 m². Annual production capacity: 350 000 bottles. Equipment: Alfa Laval company (Sweden), Padovan company (Italy).

The products of the Factory are produced in accordance with the patents 5 that belong to “Biyan” Producty LLC. The five patents were honoured with a special prize, two golden, one silver and two bronze medals in the International Forum of Women Inventors, organized in South Korea in 2019.

The manufactured products do not contain any chemical substances, preserving agents, flavourings and colourants. We ensure that our products contain 100% herbal ingredients. If not overdosing than recommended, the products do not have any side effects or adverse reactions, and can be administered both by adults and by children.

In the process of manufacturing, the extracts of liquorice and other plants are first solidified (during 7-8 hours), and then in the Department of Mixture, the extracts are added common sugar syrup. The medicinal 100% herbal and dietary supplements syrups are filled in 100 ml and 150 ml glass bottles, put into cardboard boxes, and sent to the

storehouses, provided with modern ventilation systems for the protection of the required humidity and temperature.

Liquorice roots, solidified liquorice and plant extracts, liquorice herbal syrups and water are tested at the laboratories. In accordance with the requirements of normative documents, the determination of organoleptic indices in raw materials and produced products, also mass value of side mixtures, dry substances, density pH and humidity, ash, sugar, the substances that are not soluble in hot water and glycyrrhizic acid; the detection of microbiological indices, mycotoxins, as well as aflatoxins are realized in accordance with modern analysis methods.

It is good that therapeutic syrups produced at “Biyan” Industrial Park, such as “Biyan” Syrup, Biyan “Immunovit” Syrup; Biyan “Broncho” Syrup, Biyan “Gripson” Syrup proved itself in the Covid-19 pandemic.



Many patients recovered in Covid-19 pandemic by taking only these drugs. In addition, the following therapeutic syrups helped to eliminate the complications of COVID-19: Biyan "Sed"; Biyan "Hem"; "Biyan" Syrup: Biyan "Cardio" Syrup.

The main goal of "Biyan" Products LLC is, taking into account the versatile opportunities of unique medicinal and technical raw materials, national wealth of Azerbaijan licorice - which is widely used in more than 20 sectors of the national economy, including food, pharmaceutical, has about world protected documents (patents) for various products to create "Licorice" Industrial Park, corresponding to world standards: organization of a plantation, harvesting, processing of roots and rhizomes, as well as on the basis of the most valuable biologically active components of licorice and other medicinal plants, organize production of phytopreparations highly demanded as a modern pharmaceutical products both in our country and abroad. "Biyan" Products LLC

focuses its activities on scientific and substantiated, carefully verified research results. Products highly appreciated in many countries of the CIS, Europe, as well as Eastern countries, medical syrups were awarded a special prize and a gold medal; phytopreparations of various pharmacotherapeutic areas were awarded one gold medal, one silver and two bronze medals. AT currently products of the "Biyan-Licorice" Industrial Park Azerbaijan exported to foreign countries, received positive feedback.

Conclusion

The scientific article presents the results of pharmaceutical farmakoterapeutical studies of pharmaceutical products of medicinal herb *Glycyrrhiza glabra*. It has been show that the developed therapeutic agents have anti-inflammatory, imunostimulating, antitussive, antihemoroidal, cardi tonic, antiviral, sedative, diuretic, antitumor activities, which allows them to be recommended for widespread medical use. Developed licorice-based medicinal syrups: "Licorice" syrup, Licorice "Immunovit", Licorice "Hem", Licorice "Cardio", Licorice "Broncho", Licorice "Qripson", Licorice "Uro", Licorice "Sed" are produced by the national industry "Biyan" Industrial Park Products LTD and have highly praised by buyers.

Competing interests

Authors have declared that no competing interest exist.

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HERBAL COSMETICS OF TURKIYE

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Abstract: *In recent times considerable concern has been addressed to accepting the benefits of plant compounds and for creating a natural lifestyle. In the presented manuscript the herbal cosmetic products used in Turkiye have been evaluated. In all 140 plant taxa were investigated from the traditional uses. The results revealed that 40 were used for hair care, 28 as photoprotective agents, 25 for hair loss, 24 for skincare, 19 as perfumes, 17 for bad breath, 11 for dandruff, 10 for making soap, 7 for the mouth and dental hygiene, 6 against foot odor/sweating, and 4 for other purposes. The most commonly used herbal cosmetic plant taxa are; walnut (*Juglans regia*), common nettle (*Urtica dioica*), grape (*Vitis vinifera*), chamomile (*Matricaria chamomilla*), and true laurel (*Laurus nobilis*). Walnut is most commonly used to treat the hair loss, the toothpick-plant (*Ammi visnaga*) in moral hygiene and the chaste tree (*Vites agnus-castus*) to decrease odor and sweating in feet.*

Keywords: *cosmetics, herbal products, traditional, Turkish herbs*

INTRODUCTION

Recently much interest has been directed towards understanding the potential uses of herbal products and adopting a more natural lifestyle [Malik et al., 2021; Ozturk et al., 2021, 2022]. Large populations are preferring natural foods, herbal medicines and natural healing practices to promote a healthy life [Altay, Çelik, 2011; Altay, Karahan, 2012; Altay et al., 2015; Orhan, 2017; Imanberdieva et al., 2018; Ozturk et al., 2012, 2014, 2018a-g, 2019, 2020].

The use of herbal cosmetic products too has significantly increased in recent years [Kapoor, 2005]. The cosmetic manufacturers globally are working hard to provide herbal products for skin beautification to meet the growing demand. The different parts of herbal plants including roots, stems, branches, leaves, flowers and fruits have been investigated at length together with their growing conditions vis-a-vis soil composition, amount of available water, climate change,

ecological requirements and ecophysiological behaviour related to stress conditions, harvesting, maintenance, transportation and pre-production storage conditions of plant materials from harvest to transportation, preparation method such as; crushing, grinding, boiling, distillation, pressing, drying and preparation of the final product. These investigations deal with unique skincare product ingredients like; antioxidants, perfumes, preservatives and moisturizers. All are considering their use as liquid, powder, paste, syrup, crystal together with the relevant concentrations worth use for producing a biological effect [Draelos, 2009; Basher, Buchbauer, 2010].

The current demand driven market trends in both the cosmetics and perfumery industries are for the development of plant based products. These industries have an economic interest in meeting this demand by plant derived ingredients

as consumers are attracted to the proven efficacy of natural products. The main features required for cosmetic ingredients are low cost, easy metabolism in the skin, safety, novelty, formulation stability, and efficacy. All features collectively increase both the use and demand for herbal cosmetics [Ashawat et al., 2009; Magalhaes et al., 2011]. Moreover, herbal cosmetic products are also attractive because they are generally milder and more biodegradable than synthetic cosmetics, and exhibit low toxicity profiles [Chanchali, Swarnlata, 2008; Magalhaes et al., 2011].

From the dawn of civilisations humans have made and used paints, ointments, lotions and essence (perfumes) to increase skin beauty, look younger, prevent hair loss, or change hair color [Baser, Buchbauer, 2010; Çomoğlu, 2012; Unal, 2012]. In traditional folk practices, plants have been widely used as herbal cosmetic products because cosmetic products prepared by the local people were easily available, costed less and had no side effects. This popularity of herbal medicines has continued today in the rural areas of many countries. This paper summarizes the use of herbs in the traditional cosmetics in Türkiye.

DATA ANALYSIS

Ethnobotanical studies were carried out till to date, especially those published by Baytop [1984], Basher, Buchbauer [2010], Ertuğ [2014], Yücel [2014], Altay, Karahan [2017], and Ozturk et al. [2017a, b] were evaluated at length.

Use of herbal cosmetics on the basis of different categories

A total of 140 plant taxa were identified as being used to produce herbal cosmetics (Table 1). These taxa were subsequently grouped under 11 headings, on the basis of their intended use (Figure 1).

Group 1: Hair care - In traditional practices, local inhabitants have mainly used plant products for hair care. This included 40 taxa which were specifically used in hair dyeing, hair color lightening and giving a shine to the hair (Table 1). For example; *Anthemis cretica* ssp. *tenuiloba*, *A. tinctoria*, *A. wiedemanniana*, *Bellis perennis*, *Matricaria chamomilla*, *Pegatum*

harmala, *Tanacetum mucroniferum*, *Tripleurospermum repens*, and *Vitis vinifera* have traditionally been used in the lightening of hair color as well as imparting vitality and shine. The taxa *Allium sativum*, *Amygdalus communis*, *Juglans regia*, *Trigonella foenum-graecum*, *Vitis sylvestris*, and *V. vinifera* have been implicated in hair regeneration and thickening, whereas *Alcea setosa*, *Filipendula ulmaria*, *Juglans regia*, *Ocimum basilicum*, and *Origanum onites* have been used for hair dyeing. *Juglans regia* has also been used for darkening of hair colour.

Group 2: Photoprotective agents - There is a remarkable local trend in developing natural cosmetics, especially sunscreen products with high UV protection [Saewan, Jimtaisong, 2015]. Such a group is one of the most traditional groups of cosmetic use in Türkiye. In all 28 plant taxa are used for this purpose. The most commonly used plants are; *J. regia*, *Teucrium polium*, *Arctium minus* and *Cornus mas* [Altay, Karahan, 2017].

Group 3: Against hair loss - A total of 25 plant taxa are used against hair loss. Among these the most popular ones are *Allium sativum* and *J. regia*.

Group 4: Skin care - In all 24 plants are used for skin care mostly to beautify the skin. *Amygdalus communis*, *Euphorbia macroclada*, *Euphorbia petrophila*, and *Momordica charantia* are used for this purpose as well as to treat cracked hands and lips. Moreover, *Anthemis cotula*, *Matricaria chamomilla* var. *recutita* and *Teucrium polium* are also used to soften the skin and for skin cleaning; especially for the face and eyelids in babies.

Group 5: Perfumes - In the traditional perfumes 19 plants are used because of their pleasant smell; especially their essential oil contents. The most popular plants used are; *Citrus limon*, *Pelargonium graveolens*, and *Styrax officinalis*.

Group 6: Bad breath - 17 plant taxa are recommended for treating bad breath; the most important ones are; *Anethum graveolens*, *Citrus limon*, *Foeniculum vulgare*, and *Mentha x piperita*.

Group 7: Anti-dandruff - 11 plants are used as anti-dandruff. The most popular ones are; *Juglans regia*, *Anthemis fumariifolia*, and

Matricaria chamomilla var. *chamomilla*.

Group 8: Soap making-For this purpose 10 plants are evaluated, most common ones being; *Laurus nobilis*, *Olea europaea*, and *Pistacia khinjuk*.

Group 9: Mouth and Dental Hygiene - A total of 7 plant taxa have been recorded to be in use for mouth and dental hygiene. The most popular ones are; *Ammi visnaga* and *Salvadora persica*.

Group 10: Against Foot Odor and Sweating

- In all 6 plant taxa are used for treating foot odor and sweating, the most popular being *Vitex agnus-castus*.

Group 11: Other purposes - 4 plant taxa are used differently not fitting into any other category. *Achillea aleppica* ssp. *aleppica* is used in funerals for nice smell; *Alkanna orientalis* var. *leucantha* for lip paint; *Myrtus communis* for preventing smell in newborn babies [Ozturk et al., 1983,2011] and *Sambucus nigra* is used for children's nail polish.

Table 1.
The traditionally used cosmetic products of plant origin in Turkiye.

No	Plant name	Family	Part used	* Category of use
1.	<i>Achillea aleppica</i> DC. ssp. <i>Aleppica</i>	Asteraceae	Aerial parts	11
2.	<i>Achillea biebersteinii</i> Afan.	Asteraceae	Flower	4, 5
3.	<i>Achillea crithmifolia</i> Friv. ex Hampe	Asteraceae	Flower	3
4.	<i>Adiantum capillus-veneris</i> L.	Pteridaceae	Aerial parts	7
5.	<i>Alcea calvertii</i> Boiss.	Malvaceae	Flower	4
6.	<i>Alcea setosa</i> Alef.	Malvaceae	Flower, fruit, leaves	1
7.	<i>Alkanna orientalis</i> var. <i>leucantha</i> (Bornm.) Hub.-Mor.	Boraginaceae	Root	11
8.	<i>Allium sativum</i> L.	Amaryllidaceae	Bulb	1, 2, 3
9.	<i>Ammi visnaga</i> (L.) Lam.	Apiaceae	Fruit stalk	6, 9
10.	<i>Amygdalus communis</i> L.	Rosaceae	Fruit	1, 4, 5
11.	<i>Anethum graveolens</i> L.	Apiaceae	Leaves, stem	6
12.	<i>Anthemis austriaca</i> Jacq.	Asteraceae	Flower	3
13.	<i>A. cotula</i> L.	Asteraceae	Flower, aerial parts	1, 3, 4
14.	<i>A. cretica</i> L. ssp. <i>tenuiloba</i> (DC.) Grierson	Asteraceae	Flower	1
15.	<i>A. fumarifolia</i> Boiss.	Asteraceae	Flower	3, 7
16.	<i>Anthemis</i> spp.	Asteraceae	Flower	1
17.	<i>A. tinctoria</i> L. var. <i>pallida</i> DC.	Asteraceae	Aerial parts, flower	1, 4
18.	<i>A. tinctoria</i> L. var. <i>tinctoria</i>	Asteraceae	Flower, leaves	1, 3
19.	<i>A. wiedemanniana</i> Fisch. & C.A. Mey.	Asteraceae	Flower	1, 4
20.	<i>Arctium minus</i> Boiss.	Asteraceae	Leaves	7
21.	<i>Astragalus gummifer</i> Labill.	Fabaceae	Stem	3
22.	<i>Atropa bella-donna</i> L.	Solanaceae	Fruit, leaves	4
23.	<i>Avena sativa</i> L.	Poaceae	Seed	4
24.	<i>Bellis perennis</i> L.	Asteraceae	Aerial parts	1, 3
25.	<i>Carthamus dentatus</i> Vahl	Asteraceae	Flower	5
26.	<i>C. tinctorius</i> L.	Asteraceae	Flower	5
27.	<i>Castanea sativa</i> Mill.	Fagaceae	Leaves	1
28.	<i>Cyanus segetum</i> Hill.	Asteraceae	Flower	1, 3
29.	<i>Ceratonia siliqua</i> L.	Fabaceae	Seed	5
30.	<i>Cichorium intybus</i> L.	Asteraceae	Aerial parts	1, 2, 9
31.	<i>Cistus creticus</i> L.	Cistaceae	Flower	5
32.	<i>Citrus limon</i> (L.) Osbeck	Rutaceae	Fruit	4, 5, 6

33.	<i>Colutea cilicica</i> Boiss. & Balansa	Fabaceae	Aerial parts	3
34.	<i>Coridothymus capitatus</i> Rchb.f.	Lamiaceae	Aerial parts	9
35.	<i>Cornus mas</i> L.	Cornaceae	Fruit	2
36.	<i>C. sanguinea</i> L. ssp. <i>sanguinea</i>	Cornaceae	Fruit	8
37.	<i>Cotinus coggygria</i> Scop.	Anacardiaceae	Leaves	3
38.	<i>Corylus avellana</i> L.	Betulaceae	Leaves	2
39.	<i>Cupressus sempervirens</i> L.	Cupressaceae	Leaves	10
40.	<i>Cyclamen coum</i> Mill.	Primulaceae	Tuber	8
41.	<i>Cyperus longus</i> L.	Cyperaceae	Rhizome	6
42.	<i>Daucus carota</i> L.	Apiaceae	Underground parts, seed	2
43.	<i>D. littoralis</i> Sm.	Apiaceae	Flower stalks	9
44.	<i>Elaeagnus angustifolia</i> L.	Elaeagnaceae	Flower	5
45.	<i>Eucalyptus globulus</i> Labill.	Myrtaceae	Leaves	6
46.	<i>Euphorbia macroclada</i> Boiss.	Euphorbiaceae	Latex	4
47.	<i>E. petrophila</i> C.A. Mey.	Euphorbiaceae	Latex	4
48.	<i>Filipendula ulmaria</i> (L.) Maxim.	Rosaceae	Aerial parts	1
49.	<i>Foeniculum vulgare</i> Mill.	Apiaceae	Aerial parts	6
50.	<i>Fragaria vesca</i> L.	Rosaceae	Flower, fruit	5
51.	<i>Glycyrrhiza glabra</i> L.	Fabaceae	Leaves, root	2, 9
52.	<i>Helleborus orientalis</i> Lam.	Ranunculaceae	Rhizome	2
53.	<i>Herniaria hirsuta</i> L.	Caryophyllaceae	Aerial parts	8
54.	<i>Hordeum vulgare</i> L.	Poaceae	Aerial parts	4
55.	<i>Hyoscyamus niger</i> L.	Solanaceae	Seed	9
56.	<i>Hypericum perforatum</i> L.	Hypericaceae	Aerial parts	5
57.	<i>H. scabrum</i> L.	Hypericaceae	Essential oil	2
58.	<i>Impatiens noli-tangere</i> L.	Balsaminaceae	Aerial parts	2
59.	<i>Inula viscosa</i> (L.) Aiton	Asteraceae	Leaves	1
60.	<i>Iris galatica</i> W.Irving	Iridaceae	Flower	5
61.	<i>Juglans regia</i> L.	Juglandaceae	Leaves, fruit	1, 2, 3, 4, 5, 7, 10
62.	<i>Juniperus foetidissima</i> Willd.	Cupressaceae	Fresh shoot, cone, seed	1
63.	<i>Laurocerasus officinalis</i> M.Roem.	Rosaceae	Leaves	7
64.	<i>Laurus nobilis</i> L.	Lauraceae	Leaves, seed, essential oil	1, 3, 4, 8
65.	<i>Lavandula angustifolia</i> Mill.	Lamiaceae	Flower	1, 4, 5
66.	<i>L. pedunculata</i> ssp. <i>cariensis</i> (Boiss.) Upson & S.Andrews	Lamiaceae	Flower	7
67.	<i>Lawsonia inermis</i> L.	Lythraceae	Leaves	10
68.	<i>Malus pumila</i> Mill.	Rosaceae	Fruit	2
69.	<i>Malva sylvestris</i> L.	Malvaceae	Leaves	1
70.	<i>Matricaria chamomilla</i> L. var. <i>chamomilla</i>	Asteraceae	Flower	1, 7
71.	<i>M. chamomilla</i> L. var. <i>recutita</i> (L.) Fiori	Asteraceae	Flower	4
72.	<i>Melissa officinalis</i> L.	Lamiaceae	Essential oil	5
73.	<i>Mentha aquatica</i> L.	Lamiaceae	Leaves	6
74.	<i>M. longifolia</i> (L.) Huds. ssp. <i>Longifolia</i>	Lamiaceae	Aerial parts, leaves	2, 6
75.	<i>M. longifolia</i> (L.) Huds ssp. <i>typhoides</i> (Briq.) Harley	Lamiaceae	Aerial parts	2
76.	<i>M. pulegium</i> L.	Lamiaceae	Leaves	2
77.	<i>Mentha</i> sp.	Lamiaceae	Leaves	3
78.	<i>M. x piperita</i> L.	Lamiaceae	Aerial parts	6
79.	<i>Momordica charantia</i> L.	Cucurbitaceae	Fruit, essential oils	4

80.	<i>Myrtus communis</i> L. ssp. <i>Communis</i>	Myrtaceae	Leaves, fruit	3, 6, 11
81.	<i>Nepeta italica</i> L.	Lamiaceae	Aerial parts	3
82.	<i>Nicotiana tabaccum</i> L.	Solanaceae	Leaves	8
83.	<i>Ocimum basilicum</i> L.	Lamiaceae	Aerial parts, flower	1, 5
84.	<i>Olea europaea</i> L.	Oleaceae	Fruit, essential oils	8
85.	<i>Origanum onites</i> L.	Lamiaceae	Aerial parts	1
86.	<i>Peganum harmala</i> L.	Nitrariaceae	Seed	1, 7
87.	<i>Pelargonium graveolens</i> L'Hér.	Geraniaceae	Aerial parts	5
88.	<i>Petroselinum crispum</i> (Mill.) A.W. Hill	Apiaceae	Leaves	6
89.	<i>Pinus brutia</i> Ten.	Pinaceae	Fresh twig bark	6
90.	<i>Pistacia khinjuk</i> Stocks	Anacardiaceae	Seed, essential oils	8
91.	<i>P. lentiscus</i> L.	Anacardiaceae	Fruit	3
92.	<i>P. palaestina</i> Boiss.	Anacardiaceae	Fruit	8
93.	<i>P. terebinthus</i> L. ssp. <i>terebinthus</i>	Anacardiaceae	Leaves, seed	2, 6, 8
94.	<i>P. major</i> L.	Plantaginaceae	Leaves	2
95.	<i>P. media</i> L.	Plantaginaceae	Leaves	6
96.	<i>Plumbago europaea</i> L.	Plumbaginaceae	Leaves	3
97.	<i>Polygonum maritimum</i> L.	Polygonaceae	Aerial parts	3
98.	<i>Populus tremula</i> L.	Salicaceae	Leaves, bud	1, 7
99.	<i>Portulaca oleracea</i> L.	Portulacaceae	Aerial parts	2
100.	<i>Primula auriculata</i> Lam.	Primulaceae	Flower	5
101.	<i>P. elatior</i> (L.) Hill. ssp. <i>pallasii</i> (Lehm.) W.W.Sm. & Forrest	Primulaceae	Flower	5
102.	<i>Quercus coccifera</i> L.	Fagaceae	Trunk bark	1
103.	<i>Q. infectoria</i> Oliv.	Fagaceae	Trunk bark	1
104.	<i>Raphanus raphanistrum</i> L.	Brassicaceae	Aerial parts	10
105.	<i>Rosa canina</i> L.	Rosaceae	Flower	4
106.	<i>R. damascena</i> Mill.	Rosaceae	Flower	4
107.	<i>R. gallica</i> L.	Rosaceae	Flower	4
108.	<i>Salix alba</i> L.	Salicaceae	Leaves	2, 7
109.	<i>S. armeno-rossica</i> A.K. Skvortsov	Salicaceae	Leaves	2
110.	<i>S. bornmuelleri</i> Hausskn.	Salicaceae	Leaves	2
111.	<i>S. elbursensis</i> Boiss.	Salicaceae	Aerial parts	2
112.	<i>Salvadora persica</i> L.	Salvadoraceae	Stem, root	9
113.	<i>Salvia sclarea</i> L.	Lamiaceae	Leaves	2
114.	<i>Sambucus ebulus</i> L.	Viburnaceae	Leaves	2
115.	<i>S. nigra</i> L.	Viburnaceae	Fruit	11
116.	<i>Scandix pecten-veneris</i> L.	Apiaceae	Aerial parts	6
117.	<i>Scorzonera tomentosa</i> L.	Asteraceae	Root latex	6
118.	<i>Styrax officinalis</i> L.	Styracaceae	Flower	5
119.	<i>Tanacetum mucroniferum</i> Hub. - Mor. & Grierson	Asteraceae	Flower	1
120.	<i>Teucrium chamaedrys</i> L. ssp. <i>Chamaedrys</i>	Lamiaceae	Leaves	6
121.	<i>T. polium</i> L.	Lamiaceae	Aerial parts	2, 4
122.	<i>Thymus sipyleus</i> Boiss.	Lamiaceae	Aerial parts	2
123.	<i>Thymus</i> spp.	Lamiaceae	Aerial parts	1
124.	<i>Trigonella foenum-graecum</i> L.	Fabaceae	Aerial parts	1
125.	<i>Tripleurospermum monticola</i> (Boiss. & A. Huet) Bornm.	Asteraceae	Flower	1
126.	<i>T. parviflorum</i> (Willd.) Pobed.	Asteraceae	Aerial parts, flower	1, 3, 7

127.	<i>T. repens</i> Freyn	Asteraceae	Flower	1, 4
128.	<i>T. sevanense</i> (Manden.) Pobed.	Asteraceae	Flower	1
129.	<i>Urtica dioica</i> L.	Urticaceae	Aerial parts	1, 2, 3
130.	<i>Urtica</i> spp.	Urticaceae	Aerial parts	1, 3
131.	<i>U. urens</i> L.	Urticaceae	Aerial parts	3, 10
132.	<i>Verbascum cheiranthifolium</i> Boiss. var. <i>cheiranthifolium</i>	Scrophulariaceae	Flower	3
133.	<i>V. vulcanicum</i> Boiss. & Heldr. var. <i>vulcanicum</i>	Scrophulariaceae	Flower	3
134.	<i>Veronica anagallis-aquatica</i> L.	Plantaginaceae	Leaves	2
135.	<i>V. multifida</i> L.	Plantaginaceae	Leaves	8
136.	<i>Viola sieheana</i> W.Becker	Violaceae	Flower	4
137.	<i>Vites agnus-castus</i> L.	Lamiaceae	Fresh shoot, leaves	1, 10
138.	<i>Vitis sylvestris</i> W.Bartram	Vitaceae	Stem	1
139.	<i>V. vinifera</i> L.	Vitaceae	Fruit, leaves	1, 2, 4
140.	<i>Zea mays</i> L.	Poaceae	Corn silk	1

***Note: Category of use** - 1: Hair care; 2: Photoprotective agent; 3: Against hair loss; 4: Skin care; 5: Perfume; 6: Against bad breath; 7: Anti-dandruff; 8: Soap making; 9: Mouth and dental hygiene; 10: Against foot odor/sweating; 11: Other purposes.

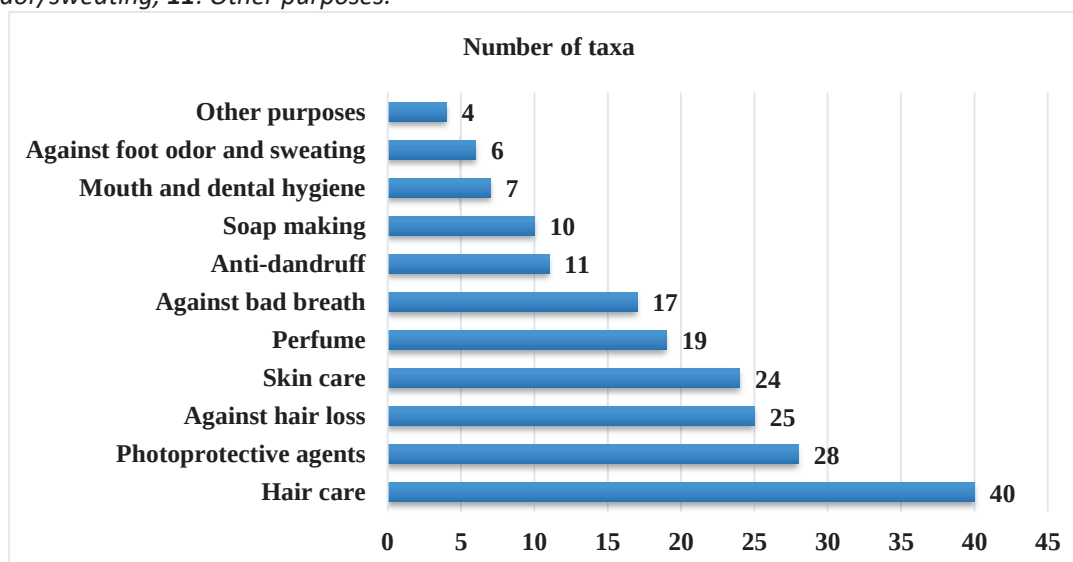


Fig. 1. Grouping of herbal cosmetics traditionally used in Turkiye.

Out of 140 plant taxa used traditionally by the locals in Turkiye, *Juglans regia* (Walnut-Ceviz) appears as the most commonly used taxon for treating foot odor and sweating, essence (perfume), skin care, anti-dandruff, against hair loss, as photoprotective agent, and for hair care. Other important taxon appears as *Laurus nobilis*, mainly used for skin care, against hair loss, hair care, and soap making. Among the herbal cosmetics traditionally used in Turkiye, especially in hair care, *J. regia*, *U. dioica*, *V. vinifera*, *M. chamomilla*, *L. nobilis* top the list. Other popular taxa are walnut (*J. regia*) (for prevention of hair loss), toothpick plant (*Ammi*

visnaga) for mouth and dental hygiene and the chaste tree (*Vites agnus-castus*) for foot odor and sweating.

The majority of these plants are collected by the locals from nature. It is posing a great threat to plant diversity. The taxa like; *Allium sativum*, *Amygdalus communis*, *Avena sativa*, *Citrus limon*, *Daucus carota*, *Fragaria vesca*, *Hordeum vulgare*, *Mentha x piperita*, *Olea europaea*, *Petroselinum crispum*, *Vitis vinifera* and *Zea mays* are still routinely purchased by the people from neighborhood markets in different regions of Turkiye. In addition, *Eucalyptus globulus*, *Lawsonia inermis*,

Momordica charantia, *Rosa damascena* and *Salvadora persica* are also widely sold by urban herbalists throughout the country.

CONCLUSIONS

Companies involved in the production of cosmetics need to cooperate with academia and non-governmental organizations to improve the current plant raw material supply chain. This can be achieved when raw materials are certified. The industry also needs sustainable plant-based raw materials, attained by establishing partnerships, where industries can also gain innovative raw materials, increase their scientific knowledge and can ultimately contribute positively towards both the economy and society [Schmidt, 2012]. To find new cosmetic active ingredients, knowledge of the bioactivity of genetic resources from local people or local communities is required [Schmidt, 2012]. An evaluation of the information gathered by different groups on the use of local herbal cosmetics helps to increase the importance of the local cosmetic industry. Considering the research studies on herbal cosmetics and medicinal plants, it is necessary to focus on research, development and conservation efforts of the plants used for this purpose. In order to protect country's sustainable and long-term natural resources, we have to be involved actively with local communities in the assessment, planning, implementation and monitoring [Ahmad et al., 2008].

The cosmetics industry has started to focus more on herbal-based cosmetics. Today herbal cosmetics is a fast-growing segment of the industry with significant expansion expected during the coming decades. For healthy skin and/or hair the biological functions of bioactive ingredients in cosmetics must be investigated properly as both need essential nutrients for a healthy look. These products also provide different plant-derived substances including

antioxidants, essential oils, hydrocolloids, proteins, terpenoids, vitamins, together with other bioactive molecules.

In the future the cosmetic industry has enormous potential to launch several new herbal cosmetic products having a range of bioactive molecules, essential oils, proteins, and additives [Aburjai, Natsheh, 2003; Kapoor, 2005; Başer, Buchbauer, 2010]. However, before this can occur safely, the most important action currently required is to develop adequate safety testing methods based on the current guidelines which accurately document ingredients composition.

At present the contribution of the Turkish market to world cosmetics is low, but can be improved through systematic research and development efforts. Wide ranging and detailed field studies are required to analyze traditional cosmetic systems from a cross-cultural perspective. Active collaboration is required between scientists, technologists, the cosmetic industry and government organizations [Kapoor, 2005]. In the future, it is likely that extracts and oils of commercial importance will be investigated from several new potential plants. Many of these may prove of great ethnobotanical use. Moreover, new isolation and extraction techniques should be developed to attain higher quality products, where different groups of researchers from chemistry (especially analytical chemists), toxicology and botany must participate actively in the evaluation of these new products [Aburjai, Natsheh, 2003].

We suggest that a detailed in-depth evaluation of the plants tabulated here is required to assess their wider use in the Turkish cosmetic industry. However, all such activities should consider their use in a sustainable way. The plant diversity in the country is offering a rich treasure for obtaining herbal raw materials and for new products that may have strong commercial use.

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EFFECT OF NANOPARTICLES ON THE *GOLDEN DELICIOUS* APPLE FLOWER FERTILIZATION PROCESS AND ACCUMULATION IN THE FRUIT

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Abstract. Attempts to use nanomaterials, including nanoparticles, to increase the productivity of agricultural plants, resistance to stress factors, as mineral fertilizers, are giving real results. Nanoparticles can play an important role in plant growth stimulation and protection. Experiments show that nanoparticles can migrate from the air, soil and water to the plants and affect a number of physiological processes. The effect of nanoparticles on plants can be both positive and negative, depending on their composition, concentration, methods of application, environmental conditions and the type of plants. In this article, the accumulation of nanoparticles in the fruits of trees, the flowers and leaves of which were sprayed with SiO₂ and Fe₃O₄ nanoparticles, and their effect on the number and composition of fruits were studied. Since the Golden Delicious type of apple tree is widely used in intensive horticulture, suitable for industrial cultivation and with high productivity, the experiments were conducted on trees of this type. The experiments were conducted in the experimental field of the Scientific Research Institute of "Fruit and Tea Cultivation" located in Zardabi settlement of Guba region (Republic of Azerbaijan) during the 2022 season. Trees were sprayed with solutions of 0.5g/l SiO₂ and Fe₃O₄ nanoparticles in deionized water during the initial flowering period and 40 days after flowering. The effect of nanoparticles on the fertilization of flowers, the number and chemical composition of fruits was studied. Diffusion and accumulation of nanoparticles in apple fruits were investigated by TEM analysis and EPR method. The results showed that nanoparticles have a significant effect on the productivity of the Golden Delicious apple variety, the chemical composition of the fruits, and they can be collected in both the peel and the fleshy part of the fruits.

Keywords: Nanoparticles, apple tree, pollination of flowers, fruits, localization of nanoparticles

Introduction

With the development of nanotechnology, which is determined to gain the status of the technology of the XXI century, it has become possible to synthesize nanoparticles that have wide practical applications and exhibit unique properties [Rai et al., 2018]. These nanoparticles, which are extremely small in size, very light in

weight, and have a high surface area relative to their volume, can spread into the environment in various ways and strongly affect the quality of soil, water, and air, which are closely related to human health [Hasimoto et al., 2017]. Therefore, plants growing at the junction of water, air and soil will be more exposed to the effect of nanoparticles. Nanoparticles with unique

properties will be a new option for mineral fertilizers used in the agricultural industry [Elmer et al., 2016] will replace herbicides used in plant protection [Worrall et al., 2018; Maruyama et al., 2016].

It is already proven that nanoparticles act as potential biostimulants that have a positive effect on the germination, development, growth, flowering and productivity of plants [Saha et al., 2018]. Nanoparticles can also play an important role in the resistance of plants to several stress factors (salinity, drought, low temperatures, radiation and chemical pollutants) [Hernández-Hernández et al., 2018; Avestan et al., 2019]. The use of nanoparticles can be very useful for agriculture and horticulture, but at the same time there are some risks related to their effects on the environment and plants that have not yet been fully studied [Feregrino-Perez et al., 2018].

Although the research devoted to the effect of nanoparticles on the growth, development and physiological processes of plants has intensified, there is a need to clarify many issues in this field. One of these issues is the process of flowering and flower fertilization, which directly affects the productivity of plants, including fruit trees. The effect of nanoparticles on flowering of fruit trees and pollination of flowers is poorly studied. The experiments were mainly carried out with annual and perennial agricultural crops. For example, [Laware and Shilpa Raskar, 2014] studied the effect of ZnO nanoparticles on onion (*Allium cepa* L.) plant development and flowering. They sprayed onion plants 3 times in 15 days with a suspension solution of ZnO nanoparticles in the range of 20 and 30 µg ml⁻¹. Growth parameters such as plant height, number of leaves and flowering period were determined. Seed samples from plants in nanoparticle sprayed plants were tested for germination and early germination along with controls. Plants sprayed with nanoparticles developed better and flowered 12-14 days earlier than plants without nanoparticle application. This result shows that ZnO nanoparticles can reduce the flowering time in

onion plants by 12-14 days and even healthier seeds are obtained [Laware and Shilpa Raskar, 2014]. In another experiment, Ag nanoparticles were applied to *Lilium* cv. studied the effect on flowering and a number of physiological parameters in the plant. In these experiments, lily tubers were first kept in a solution with a concentration of 100 ppm of Ag nanoparticles for 60 minutes and planted. It has been found that Ag nanoparticles stimulate the growth and flowering of plants, increase the amount of chlorophyll and carotenoids, increase the greening index of leaves, the number of flowers and the formation of larger flowers [Piotr Salachna et al., 2019]. Silver nanoparticles were also used by Troong Hoai and Phong et al. in *Passiflora edulis* Sims f. The effect of budding, flowering on fruit formation processes in *edulis* bicysin was investigated in in vitro experiments. The results of the experiments showed that the introduction of Ag nanoparticles into the nutrient medium increased the rate of flowering by 51.67% and the number of flowers by 2.33 times compared to the control 60 days after planting. In plants treated with Ag nanoparticles with a concentration of 7 mg/l, flowering was 100%, the diameter of the flowers was 3.43 cm. Flowers self-pollinated and fruits formed in test bottles. The fertilization of the flowers was 56.67%, and the diameter of the fruits reached 1.13 cm [Truong Hoai Phong et al., 2022].

In their experiments, Zeynab Seydmohammadi and her colleagues studied the effect of ZnO and CaCO₃ nanoparticles on the development and flowering of *lisianthus* (*Eustoma grandiflorum* variety Mariachi Blue). The experiments were carried out in a greenhouse. and sprayed every 20 days with solutions at a concentration of 750 mg/l. It was clear from the obtained results that ZnO nanoparticles (6 mg/l) increased the number of flowers and side branches, and the amount of chlorophyll and anthocyanins in leaves. In plants sprayed with CaCO₃ at a concentration of 500 mg/l flowering occurs 15 days earlier, the number of flowers is 56.3% more than the control [Zeynab Seydmohammadi, et al., 2020].

The analysis of literature data in this field

shows that the effect of nanoparticles on flowering in plants and pollination of flowers has been little studied. In our presented article, the effect of SiO_2 and Fe_3O_4 nanoparticles on the fertilization of flowers in apple trees, the number and mass of fruits and the accumulation of these nanoparticles in the fruit were investigated.

1. Material and methods

1.1 Design of experiments and apple tree.

The Golden Delicious type of apple tree was used in the experiments. In the scientific literature, the *Golden Delicious* type is shown as a hybrid of the *Grimes Golden* and *Golden Reinette* varieties. It was first found at the end of the 19th century in West Virginia, USA. Golden Delicious apple trees are small, reaching 3 m in height. The first fruits appear 2-3 years after planting. In the first year, the fruits are weak, but in the second, the branches harvest. 2-3 apples grow at one place on the branch. At the age of 6-7, it is possible to collect up to 17 kg of fruit from one tree. *Golden Delicious* apple trees are

long-lived. They can live up to 30 years and bear fruit. The crown of the trees is round and dense. Apple trees need pruning every year. The leaves are oval, wrinkled and sharp. The leaf plate is light green, the color of the flowers is white and pink. The branches fall down when bearing fruit. *Golden Delicious* is a late ripening (winter) apple variety, resistant to diseases and cold. Harvest is the end of September. The *Golden Delicious* apple tree is susceptible to powdery mildew in humid regions, the disease is observed on shoots, buds and leaves, the disease symptom is similar to the appearance of a whitish flower. This apple variety is drought tolerant. After harvesting, it is possible to keep the fruits of this variety for a long time. The fruits are medium-sized, round-conical, long-stalked, yellow-green, sparsely speckled. The pulp of the fruit of the Golden Delicious variety is dense, slightly sour, juicy and pleasantly fragrant. The average weight of the fruit is 136 g. The amount of sugar in the fruits is 10-13%, the fruits turn golden yellow when ripe.



Fig. 1. *Golden Delicious* apple tree (left) and their fruit (right)

Experiments were conducted in the experimental area of the Scientific Research Institute of "Fruit and Tea Cultivation" located in Zardabi settlement, Guba region, during the season of 2022. In order to study the effect of nanoparticles, nine trees planted in an area of 40 m², with a distance of 1m 40 cm between each tree, were used. In all variants, apple trees were sprayed with a dispersed solution of nanoparticles twice during the season. In the first spraying, only the flowers of the trees were sprayed on April 20. The second spraying was 40 days after the first. At this time, only the leaves of the trees were sprayed and the nanoparticles were also given to the roots. Experiments were conducted in three variants (A, B, C). In option A, 3 apple trees were treated with a dispersed solution of SiO₂ nanoparticles with a size of 20 nm at a concentration of 0.5 g/l. Initially, in this variant, the flowers and leaves of each of the 3 apple trees were sprayed with a solution of nanoparticles in the same quantity. In addition to spraying the leaves, the roots of the trees were also watered with this solution. In option B, 3 apple trees were taken as a control option maintained under normal conditions. Procedures were performed as in option A, but without nanoparticle application. In version C, Fe₃O₄ nanoparticles with sizes of 20-30 nm were used. As in option A, the flowers and leaves of the trees were sprayed with a dispersed solution of Fe₃O₄ nanoparticles with a concentration of 0.5 g/l, and the roots were watered. During the season, phenological and biometric observations were made.

1.2 Nanoparticles and preparation their solutions.

SiO₂ and Fe₃O₄ nanoparticles used in the experiments were purchased from Skyspring Nanomaterials, Inc, Houston TX, USA. The sizes of powdered SiO₂ and Fe₃O₄ nanoparticles were in the range of 20-30 nm. Nanoparticles were dissolved in deionized water at the rate of 0.5 g/l to obtain a dispersed solution. Before application, in order to avoid agglomeration of nanoparticles, the dispersed

solution was processed in an ultrasonic sonicator (QSONiCa sonicator) for 10 minutes. The leaves of the trees were sprayed with a spray method in a short time interval. The roots of the trees were also watered with the dispersed solution.

1.3 EPR method

Absorption and localization of Fe₃O₄ nanoparticles in apple fruits was detected by EPR method. First, the EPR spectrum of the solution of Fe₃O₄ nanoparticles was recorded on a Bruker ESP300E (Bruker, Germany) device, and the accumulation of these nanoparticles in plant fruits was determined based on the change in the EPR signal. Samples were taken from the pulp and peel of apple fruits grown in options B and C, and sections were prepared and dried in a vacuum device. EPR signals of Fe₃O₄ nanoparticles in dried samples were recorded.

1.4 TEM spectroscopy method

In order to detect the absorption and accumulation of nanoparticles in apple fruits, samples were taken from apple fruits grown in all three variants and prepared for TEM analysis. The samples were fixed in a solution consisting of 2% paraformaldehyde, 2% glutaraldehyde and 0.1% picric acid prepared in 0.1M phosphate buffer (pH 7.4). After remaining in the fixative for 24 hours, the samples were postfixed in 1% osmium tetroxide solution prepared in phosphate buffer (pH 7.4) for two hours. Araldite-Epon blocks are prepared from the material based on the general protocols adopted in electron microscopy (Kuo, 2014). Semi-thin (1-2µm) sections taken from the blocks on a Leica EM UC7 ultramicrotome were stained with methylene blue, azur II and base fixin or toluid blue, viewed under a Primo Star (Zeiss) microscope, and pictures of the necessary parts were taken with an EOS D650 (Canon) digital camera (D' Amico, 2005). Ultrathin sections of 50-70 nm thickness taken from the same blocks were first stained with 2% uranyl-acetate solution and then with 0.6% pure lead citrate prepared in 0.1N NaOH solution.

Ultrathin sections were examined under a JEM-1400 transmission electron microscope under a voltage of 80-120 kV and electrograms were recorded. The morphometric analysis of the image was performed on electrograms taken in TIF format using the computer program (The TEM imaging platform) developed by the German company "Olympus Soft Imaging Solutions GmbH".

3. Results of experiments

3.1 Phenological observations

The *Golden Delicious* apple trees used in the experiments were planted in the open field in 2016 in seedling form. At the time of the experiment, the trees were 6-year-old trees in the 2022 season. As a result of phenological observations, tree development and fruiting stages were monitored. The

period from awakening of generative organs and flower buds to fruit harvesting was observed. Observations have shown that the flower buds begin to wake up in the second decade of April, the initial awakening of the buds occurs on April 13. The first flowering is observed a week after the awakening of the shoots. A week after the first flowering, the trees are in full bloom, and on May 5, flowering and fertilization of the flowers ends. Starting from this period, the process of formation and growth of fruits begins. The fruits of *Golden Delicious* apple trees ripen until September 20, and harvest begins from this period. Table 1 shows the results of phenological observations made in 2022 on trees belonging to the *Golden Delicious* apple variety in the study area.

Table 1.
Phenological observations of the Golden Delicious variety for the 2022 season

Observation days	Phenological changes
13.04.2022	Awakening of flower buds
19.04.2022	First flowering
04.25.2022	Full bloom
05.05.2022	End of flowering
19.09.2022	Fruit ripening period and harvesting

3.2 Biometric observations

Along with phenological observations, biometric measurements of trees were also taken. Biometric measurements were carried out during the first flowering (20.04.2022) and fruit development (08.06.2022). At this time, biometric measurements of one tree were taken from each of the three areas allocated for the experiment. It was determined that in the first flowering period, the average height of the 3 trees of the area selected for option A was 180 cm, the diameter of the trunks was 6 cm, the average length of the leaves was 5 cm, and the width was 2 cm. The average height of the 3 trees in option B was 140 cm, the diameter of the trunk was 9 cm, the average length of the leaves was 5 cm, and the width

was 2 cm. The average height of the trees selected for option C was 140 cm, the diameter of the trunk was 9 cm, the average length of the leaves was 4.5 cm, and the width was 2 cm. During the period of fruit development, the trees grew and the biometric measurements were as follows: the average height of the 3 trees of the selected area for option A was 220 cm, the diameter of the trunk was 9 cm, the average length of the leaves was 8 cm, and the width was 6 cm, the number of ripening fruits was 173. The average height of the 3 trees in variant B was 240 cm, the diameter of the trunk was 9 cm, the average length of the leaves was 9 cm, and the width was 6 cm. The number of ripening fruits was 60. The average height of the trees selected for option C was

170 cm, the diameter of the trunk was 10 cm, the average length of the leaves was 11 cm, and the width was 6 cm, and the number of ripening fruits was 144.

3.3 Pomological observations

In apple trees treated with nanoparticles, the main issue was the fertilization rate of their flowers and ultimately the number of fruits. After application of SiO₂ and Fe₃O₄ nano-

particles, the number of ripe fruits was determined in all three variants. Observations have shown that SiO₂ and Fe₃O₄ nanoparticles have a significant effect on the fertilization of flowers and finally on the number, weight and size of fruits compared to the control option. Pomological observations were made during fruit ripening and harvesting (19.09.2022). The results of observations are given in Table 2.

Table 2.
Effect of SiO₂ and Fe₃O₄ nanoparticles on number, weight and size of fruits

Variants Tree number	The number of ripe fruits, units	Total weight of ripe fruits, kg	Size of fruit contour, Cm	Fruit height, cm
Variant A, Tree 1	173	13.7±0,25	20±0,07	6±0,03
Variant A, Tree 2	8	1.2±0,32	20±0,03	6.5±0,06
Variant A, Tree 3	140	13.6±0,43	21±0,05	7±0,04
Variant B, Tree 1	3	0,4±0,15	20±0,04	6±0,08
Variant B, Tree 2	60	7.4±0,22	21,5±0,08	6.2±0,06
Variant B, Tree 3	12	1,5±0,12	20±0,06	6.5±0,05
Variant C, Tree 1	126	10.4±0,25	21.2±0,09	6.5±0,04
Variant C, Tree 2	17	1.9±0,14	21±0,07	6.5±0,02
Variant C, Tree 3	91	8.9±0,28	21±0,08	6.5±0,03

3.4 Compositional analysis of fruits

The composition of fruits of trees sprayed with nanoparticles was also analyzed. Monosaccharides, sucrose, vitamin C, soluble dry matter and the characteristics of fruits were analyzed in the experiments. The fruits of all three variants were analyzed. The results of the analysis are given in Table 3. The results of the analysis showed that the amount of monosaccharides in the fruit of the trees selected from option A (sprayed with SiO₂ nanoparticles) was higher than that of the control option, and the percentage of sugars in general differed. The increase in the percentage of vitamin C was greater in variant C (sprayed with Fe₃O₄ nanoparticles).

3.5 Accumulation of nanoparticles in fruits

The use of nanoparticles in agriculture for

various purposes creates a number of environmental and health risks. Therefore, a detailed study of the interaction of nanoparticles with plants serves to clarify a number of questions in this field. The most important of these questions are the toxicity of nanoparticles, their physiological effects in plants, their influence on biochemical and physiological processes, and finally their migration to and accumulation in plant organs. From the information given in the literature review, it is clear that the effects of nanoparticles on the duration of flowering and flowering stages in flowering plants were considered in the experiments. From the results of these experiments, it was clear that parameters such as height, number of leaves, seed size and seed weight of onion (*Allium cepa* L.) plants sprayed with ZnO nanoparticles

improved. Plants treated with ZnO nanoparticles at concentrations of 20 and 30 $\mu\text{g ml}^{-1}$ developed better and flowered 12-14 days earlier than the control [Laware and Shilpa Raskar, 2014]. Ag nanoparticles affect plant growth and flowering stimulates, increases the amount of chlorophyll and carotenoids, increases the greening index of the leaves, the number of flowers and the formation of larger flowers. Nanoparticles on the growth and flowering of potted oriental Lilies, *Agronomy* 2019, 9, 610; doi:10.3390/agronomy9100610) *Passiflora edulis* Sims f. In the in vitro experiments conducted with *edulis* biki, the introduction of Ag nanoparticles into the nutrient medium increased the rate of flowering by 51.67% and the number of flowers by 2.33 times compared to the control 60 days after planting [Truong Hoai Phong, 2022].

As already mentioned in the experimental procedure, apple trees were sprayed twice during the season with dispersed solutions of SiO_2 and Fe_3O_4 nanoparticles. The first spraying was during the flowering period of trees and only flowers were sprayed. Second spraying 40 days after the first. At this time, only the leaves of the trees were sprayed. During this period, flowers have already fertilized and fruits have formed. This was followed by the stage of fruit development. The main goal of our experiments was to test whether nanoparticles diffuse into apple fruits. The fact that the productivity of trees and the number of fruits is higher than in the control indicates a positive effect of spraying flowers with nanoparticles on the fertilization process. Therefore, a hypothesis was put forward that the nanoparticles could get into the flower bed during fertilization and remain in the fruits. To test this, we took samples of ripe fruits for TEM analysis and examined the presence of SiO_2 and Fe_3O_4 nanoparticles in the fruits. Samples were taken from the skin of the apple fruit, its fleshy part and pulp. In the Figure 2 shown optical and TEM images of the peel of the *Golden Delicious* apple

fruit. The images was taken on the optical microscope (fig.2A), by the TEM of the peel of the apple taken from the control variant (fig.2B) and TEM image of the peel of the fruit of the flowers sprayed with SiO_2 nanoparticles (fig.2C). In the Figure 3 shown optical and TEM images of the peel of the *Golden Delicious* apple fruit. The images was taken on the optical microscope (fig.3A), by the TEM of the peel of the apple taken from the control variant (fig.3B) and TEM image of the peel of the fruit of the flowers sprayed with Fe_3O_4 nanoparticles (fig.3C). In the Figure 4 shown optical and TEM images of the flashy part of the *Golden Delicious* apple fruit. The images was taken on the optical microscope (fig.4A), by the TEM of the flashy part of the apple taken from the control variant (fig.4B) and TEM image of the flashy part of the fruit of the flowers sprayed with SiO_2 nanoparticles (fig.3.C). Figure 5 shown optical and TEM images of the flashy part of the *Golden Delicious* apple fruit. The images was taken on the optical microscope (fig.5A), by the TEM of the flashy part of the apple taken from the control variant (fig.5B) and TEM image of the flashy part of the fruit of the flowers sprayed with Fe_3O_4 nanoparticles.

We also tested the diffusion and accumulation of nanoparticles in apple fruits using the EPR method. Samples for EPR were taken from tree fruits, the flowers of which were sprayed with Fe_3O_4 nanoparticles. EPR signals were taken from the peel and flashy part of fruits taken from the normal control variant, as well as from the peel and flashy part of fruits of trees treated with Fe_3O_4 nanoparticles. Figure 6 shows the EPR signals. The results showed that these are signals of iron oxide, but it cannot be said that these signals are signals of Fe_3O_4 nanoparticles. Because the signals obtained from the variant with the application of Fe_3O_4 nanoparticles do not differ from the signals of the control variant without the use of Fe_3O_4 nanoparticles.

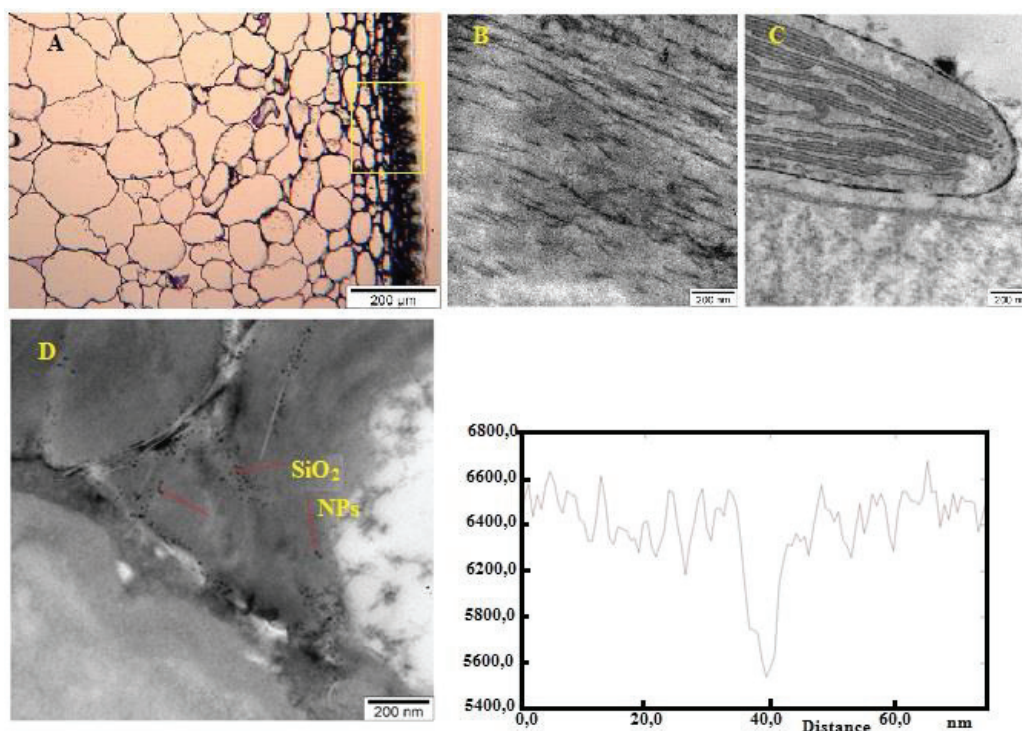


Fig. 2. TEM image of the peel of the Golden Delicious apple tree: A - optical microscope image, B - TEM image of the peel of the apple taken from the control variant, C - TEM image of the peel of the fruit of the flowers sprayed with SiO_2 nanoparticles.

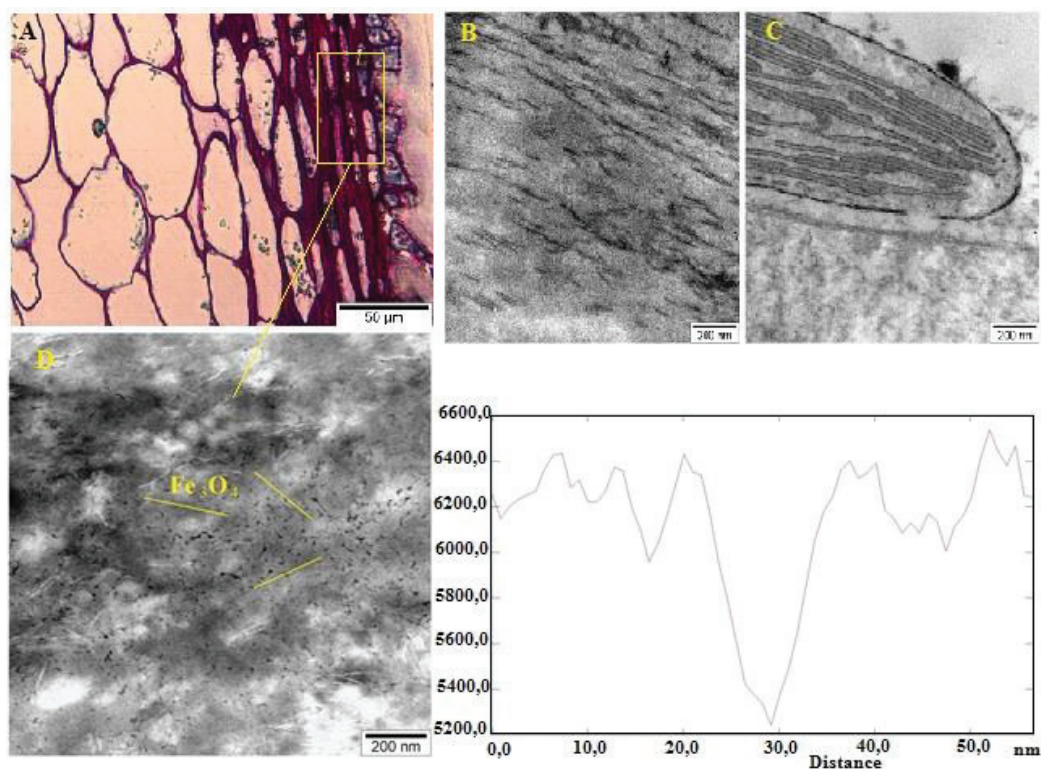


Fig. 3. TEM image of the peel of the Golden Delicious apple tree: A - optical microscope image, B - TEM image of the peel of the apple taken from the control variant, C - TEM image of the peel of the fruit of the flowers sprayed with Fe_3O_4 nanoparticles.

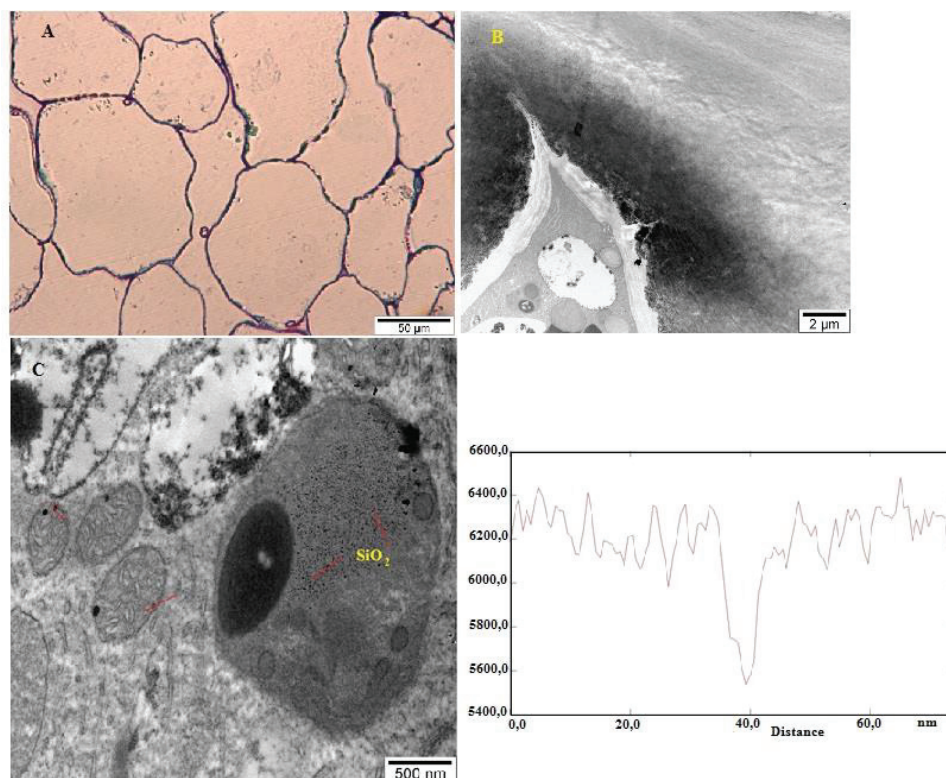


Fig. 4. TEM image of a sample taken from the fleshy part of the fruit of the Golden Delicious apple tree:
A - optical microscope image, B - TEM image of the peel of the apple taken from the control variant,
C - TEM image of the peel of the fruit of the flowers sprayed with SiO nanoparticles.

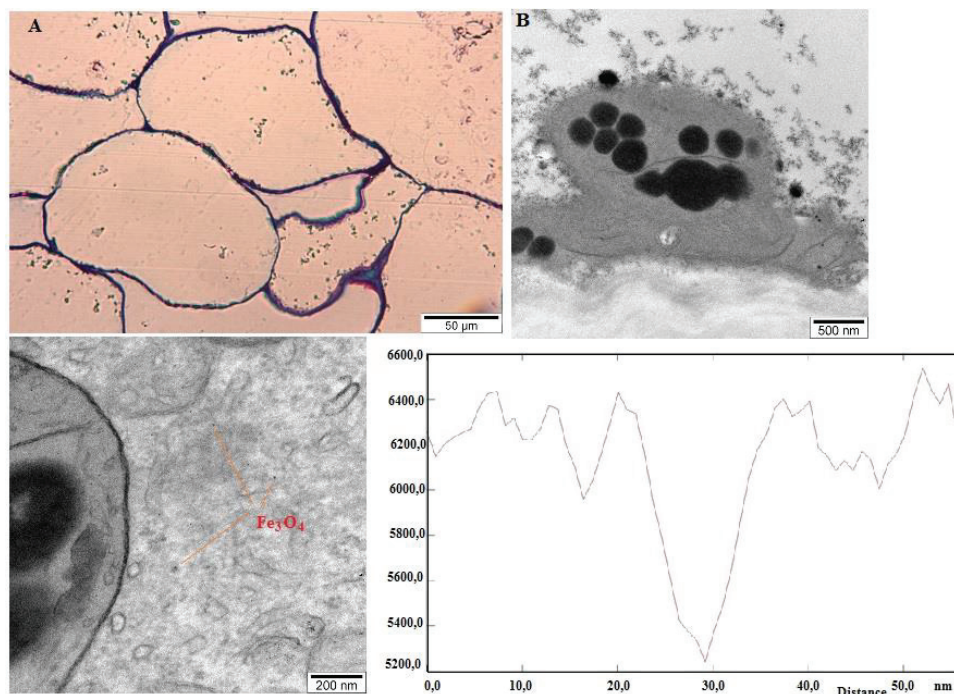


Fig. 5. TEM image of a sample taken from the fleshy part of the fruit of the Golden Delicious apple tree:
A - optical microscope image, B - TEM image of the peel of the apple taken from the control variant,
C - TEM image of the peel of the fruit of the flowers sprayed with Fe₃O₄ nanoparticles.

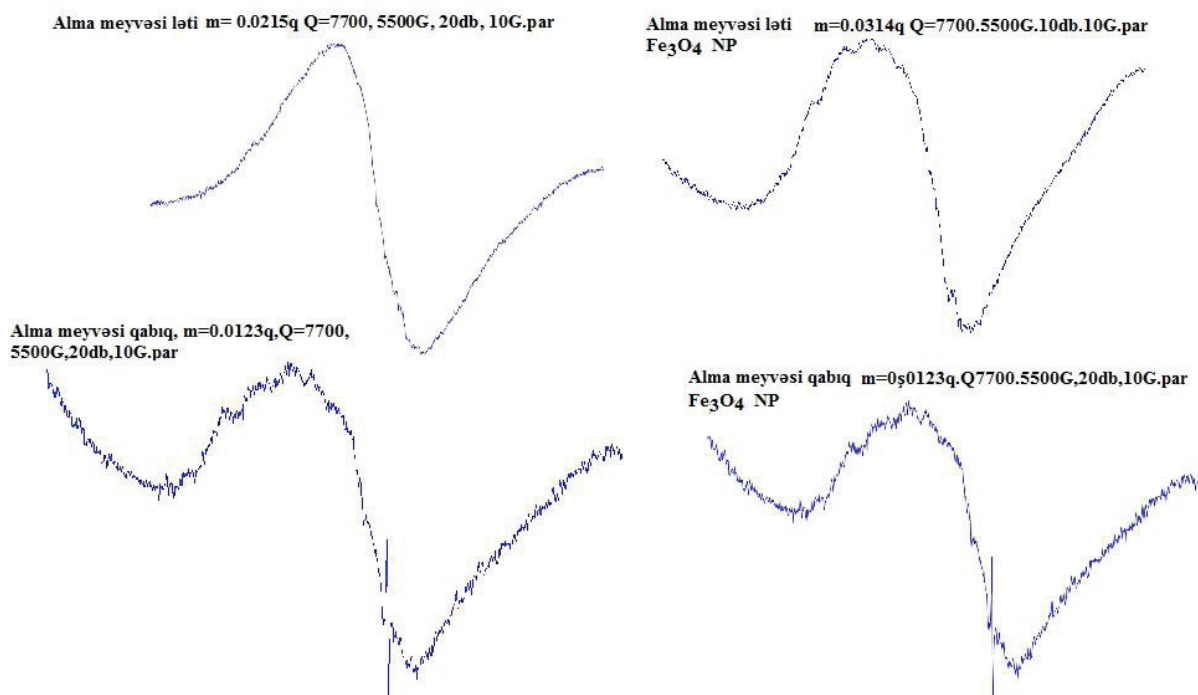


Fig. 6. EPR signals of the apple fruit which has sprayed with Fe_3O_4 nanoparticles in the flowers period

Conclusion

At present, in all studies of the migration of nanoparticles in plant organs, the patterns of movement, accumulation, and transformation of nanoparticles are poorly understood, and there are only limited data and experimental data explaining the localization and movement of nanoparticles. Movement of metal-based nanoparticles in plant organs can occur by symplastic, apoplastic, or plasmodesmal pathways. However, the exact mechanism of capture, movement, and aggregation of NPs has not yet been confirmed. Our study showed that by spraying apple tree flowers and leaves with solutions of SiO and FeO nanoparticles,

the efficiency of flower fertilization can be increased. Effective pollination of flowers ultimately results in a large number of fruits on the tree. On the other hand, SiO and FeO nanoparticles also change the composition and size of fruits. It has been interesting that nanoparticles can be collected in the peel, lat part and seed during the development of the fruit after the fertilization process of the flowers. It was clearly shown by the results of TEM analysis that nanoparticles can be collected in fruits formed from flowers sprayed with nanoparticles. Therefore, it is required to carry out these experiments in detail and more deeply.

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ANALYSIS OF THE RELATIONSHIP OF THE CULTIVATED DENDROFLORA OF THE NORTH-EASTERN PART OF THE GREATER CAUCASUS (AZERBAIJAN) TO SOME ABIOTIC FACTORS**ELMAN ISKENDER¹, AYNUR ALIYEVA², SHAFAG BAGIROVA³**¹ Institute of Microbiology, Badamdar highway 40, Baku, Azerbaijan² Sumgait State University, Baku Street, Sumqayit 5008, Baku, Azerbaijan³ Baku State University st. Academician Zahid Khalilov, 23., Baku, Azerbaijan¹ Correspondence acae55@hotmail.com

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Abstract: *In the article, the attitude of 115 types of woody plants belonging to the research object used in the ex situ conditions of the North-Eastern part of the Greater Caucasus (Azerbaijan) to environmental factors was analyzed and environmental factors such as heat, light, water, wind, which affect the growth and development of the studied species, were studied. The impact on plants was reflected in the research work. As a result of the research, it was determined that 101 species of the plants belonging to the research material are light-loving and 14 are shade-loving, and 97 species are wind-resistant and 18 are wind-resistant according to their attitude to the wind. The 37 studied during the study when studying one-day temperature changes at the height from the soil surface to the top of the plant on woody trees and shrubs, it was found that, depending on the species, the temperature is 4-7°C lower than the area near the soil surface. The results of the analyzes showed that the highest temperature in the studied 37 types of woody plants is between 26-32°C at the closest distance to the soil around 13-14 hours, and decreases in temperature are observed as the distance from the soil surface increases.*

In the article, while studying the relationship of the studied species to water, it was found that 2 of these species are hygrophytes, 56 are mesophytes, 23 are xerophytes, 9 are mesoxerophytes, and 25 are xeromesophytes. The results of the researches have shown that the environmental factors that have a decisive effect cause a number of changes in the growth and development of the studied plants.

The results of the research showed that the studied trees and shrubs have different ecological needs according to their water requirements, and can be widely used in the greening of cities and towns of different regions according to their wishes.

Keywords: *Greater Caucasus, ecological, light, temperature, ex situ*

Introduction

The protection of nature, including natural resources, and in general, the protection of the gene pool of the world's flora, is of great importance for the solution of both global and any country's environmental problems. In this regard, the eco-biological study of plants, including trees and shrubs, in ex situ and in situ conditions is of great interest both theoretically and practically [Iskender, 2008; 1993].

It is known that any plant species is affected by a number of environmental factors with different characteristics both in situ and ex situ. These environmental factors affect plants directly or indirectly. These factors affecting plants sometimes reduce the number of individuals of the species, have a negative effect on their reproduction and other developmental characteristics. [Iskender & Sadigova, 2018; Iskender, 2011]. The impact of these factors

affecting the growth and development of plants (heat, light, water, wind) on the studied plants is reflected in the research work.

Materials and Methods

115 types of trees and shrubs used in landscape architecture in the research area constituted the material of the research work. Experiments related to the research work were carried out in the study area under ex situ conditions. A number of [Ahmatov 1972; Beideman, 1979; Henkel, 1956; Iskender, 2008; 1993; Molchanov & Smirnov, 1967;

Zaytsev 1981] methods were used in the performance of the work.

Results and Discussion

It is known that in recent years there have been sharp temperature rises in the summer months. In order to find out how these temperature rises affect research plants, an experiment was set up and one day temperature changes were studied in this experiment.

The research was conducted on 37 types of research materials in the third decade of July.

Table 1.

Temperature changes in some introduced tree and shrub species in the study area (July 2020)

№	Species	Height above the ground (trunk)		
		Temperature C°		
		0	Medium	Hill
1	2	3	4	5
1.	<i>Albizia julibrissin</i>	30,0±1,5	26,0±1,3	24,0±1,2
2.	<i>Acer pseudoplatanus</i>	29,0±1,5	26,0±1,3	25,0±1,2
3.	<i>Acer laetum</i>	29,0±1,5	25,0±1,2	24,0±1,2
4.	<i>Buxus sempervirens</i>	27,0±1,3	24,0±1,2	23,0±1,1
5.	<i>Celtis caucasica</i>	30,0±1,5	25,0±1,2	24,0±1,2
6.	<i>Celtis australis</i>	30,0±1,5	26,0±1,3	24,0±1,2
7.	<i>Colutea orientalis</i>	30,0±1,5	26,0±1,3	24,0±1,2
8.	<i>Colutea arborescens</i>	30,0±1,5	27,0±1,3	25,0±1,2
9.	<i>Cotoneaster horizontalis</i>	27,0±1,3	25,0±1,2	24,0±1,2
10.	<i>Cotoneaster melanocarpus</i>	26,0±1,3	25,0±1,2	24,0±1,1
11.	<i>Diospyros lotus</i>	30,0±1,5	26,0±1,3	25,0±1,2
12.	<i>Euonymus japonica</i>	29,0±1,5	26,0±1,3	24,0±1,1
13.	<i>Ficus hyrcana</i>	30,0±1,5	26,0±1,3	25,0±1,2
14.	<i>Gleditsia triacanthos</i>	29,0±1,5	26,0±1,3	24,0±1,2
15.	<i>Laurus nobilis</i>	28,0±1,4	23,0±1,2	22,0±1,1
16.	<i>Ligustrum japonicum</i>	26,0±1,3	23,0±1,2	21,0±1,1
17.	<i>Ligustrum vulgare</i>	31,0±1,5	28,0±1,4	27,0±1,3
18.	<i>Parrotia persica</i>	28,0±1,4	26,0±1,3	24,0±1,2
19.	<i>Paulownia tomentosa</i>	29,0±1,5	26,0±1,3	23,0±1,2
20.	<i>Platanus orientalis</i>	30,0±1,5	26,0±1,3	22,0±1,1
21.	<i>Prunus persica</i>	29,0±1,5	27,0±1,3	24,0±1,2
22.	<i>Populus hyrcana</i>	30,0±1,5	27,0±1,3	25,0±1,2
23.	<i>Populus euphratica</i>	30,0±1,5	28,0±1,4	26,0±1,2
24.	<i>Pyracantha coccinea</i>	30,0±1,5	26,0±1,3	23,0±1,1
25.	<i>Pyrus caucasica</i>	31,0±1,6	25,0±1,2	24,0±1,2
26.	<i>Pyrus communis</i>	30,0±1,5	26,0±1,3	24,0±1,2
27.	<i>Pyrus salicifolia</i>	32,0±1,6	29,0±1,4	26,0±1,2
28.	<i>Quercus iberica</i>	30,0±1,5	27,0±1,3	24,0±1,2
29.	<i>Quercus ilex</i>	30,0±1,5	27,0±1,3	25,0±1,2

30.	<i>Quercus macranthera</i>	29,0±1,5	26,0±1,3	24,0±1,2
31.	<i>Quercus castaneifolia</i>	29,0±1,5	26,0±1,3	25,0±1,2
32.	<i>Robinia pseudoacacia</i>	30,0±1,5	27,0±1,3	25,0±1,2
33.	<i>Salix caprea</i>	31,0±1,6	27,0±1,4	26,0±1,3
34.	<i>Salix babylonica</i>	30,0±1,5	26,0±1,3	24,0±1,2
35.	<i>Tilia caucasica</i>	29,0±1,5	26,0±1,3	24,0±1,2
36.	<i>Ulmus minor</i>	31,0±1,5	28,0±1,4	25,0±1,2
37.	<i>Zelkova carpinifolia</i>	30,0±1,5	27,0±1,3	24,0±1,2

The results of the analyzes showed that the highest temperature in all studied plants occurs at the closest distance to the soil around 13-14 hours. Decreases in the amount of temperature have been observed as you move away from the earth's surface. The recorded temperature in the area closest to the soil surface was found to be between 26-32°C depending on the species (Table 1.).

Our observations have shown that, depending on the species, the temperature at the height from the soil surface to the top of the plant is 4-7°C lower than the area near the soil surface.

An increase in temperature causes protein breakdown, ammonia accumulation and cell structure disruption in plants [Iskender, 2008; Kurbanov, 2004].

As we know, the lack of rainfall in the summer months in the study area leads to a decrease in the amount of water in the soil. More water evapotranspiration by plants leads to further decrease in the amount of water in the soil. Thus, there is an inverse correlation between the amount of rain and water evaporation of plants. In such a situation, there is a delay in the growth and development of introduced plants in the study area. Our observations on the studied plants have shown that yellowing, burns and shedding are observed on the leaves of some of the studied species. For example, *Parrotia persica*, *Populus*

hyrcana, *Platanus orientalis*, *Pyrus caucasica*, *Quercus castaneifolia*, *Euonymus latifolia*, *Albizia julibrissin*, *Diospyros lotus*, *Euonymus latifolia*, *Acer pseudoplatanus*, etc. As a result of phenological observations, it was found that these burns observed on the leaves of plants first start from the edges of the leaf and develop towards the middle of the leaf, covering the entire leaf area, and as a result, the leaf falls.

During the research, we tried to study the stability of the studied plants against light and wind.

As we know, the increase and decrease of day length causes leaf shedding, flowering, branching, leaf splitting, pigment formation, etc. in plants. affects such processes [Tarakanov 2005].

From this point of view, plants are divided into 2 groups - short and long day plants.

It is known that from an ecological point of view, plants that are spread in different geographical regions have acquired signs of ecological adaptation due to the light time of that place. It was found that 101 species of the studied plants are light-loving and 14 are shade-loving (table 2.).

During the conducted phenological observations, it was revealed that some morphological changes occurred in some of the light-loving introducers studied. The stems of such plants are thick and tall and very branched.

Table 2.
Attitude of studied plants to rainfall and wind

No	Species	Light-loving	Shadow lover	Wind resistance
1	2	3	4	5
<i>Pinophyta</i>				

1.	<i>Abies nordmanniana</i> Spach.		+	-
2.	<i>Cedrus libani</i> A.Rich	+		-
3.	<i>Cupressus sempervirens</i> L.	+		-
4.	<i>Cupressus sempervirens</i> L. var. <i>horizontalis</i> (Mill). Gord.	+		-
5.	<i>Cupressus sempervirens</i> L. var. <i>pyramidalis</i> Targ.	+		-
6.	<i>Cupressus arizonica</i> Greene.	+		+
7.	<i>Cupressus x leylandii</i> A.B.Jacks & Dallim	+		+
8.	<i>Juniperus communis</i> L.	+		+
9.	<i>Juniperus sabina</i> L.	+		+
10.	<i>Pinus eldarica</i> Medw.	+		+
11.	<i>Pinus halepensis</i> Mill.	+		+
12.	<i>Pinus pinea</i> L.	+		+
13.	<i>Taxus baccata</i> L.		+	-
14.	<i>Taxus cuspidata</i> Sieb.et Zucc.		+	-
15.	<i>Thuja orientalis</i> L.	+		+
Magnoliophyta				
16.	<i>Abelia grandiflora</i> Rehd.	+		+
17.	<i>Acacia dealbata</i> Link.	+		+
18.	<i>Acer campestre</i> L.		+	+
19.	<i>Acer velutinum</i> Boiss.		+	+
20.	<i>Acer pseudoplatanus</i> L.		+	+
21.	<i>Acer laetum</i> C.A.Mey.		+	+
22.	<i>Agave americana</i> L.	+		+
23.	<i>Ailanthus altissima</i> (Mill.) Swingle.	+		+
24.	<i>Albizia julibrissin</i> Durazz.	+		+
25.	<i>Berberis thunbergii</i> DC.	+		+
26.	<i>Berberis vulgaris</i> L.	+		+
27.	<i>Buxus sempervirens</i> L.		+	+
28.	<i>Broussonetia papyrifera</i> (L.) Vent.	+		+
29.	<i>Catalpa bignonioides</i> Walt.	+		+
30.	<i>Carpinus betulus</i> L.		+	+
31.	<i>Castanea sativa</i> Mill.		+	-
32.	<i>Celtis caucasica</i> Willd.	+		+
33.	<i>Cercis siliguastrum</i> L.	+		+
34.	<i>Cornus mas</i> L.		+	-
35.	<i>Colutea arborescens</i> L.	+		+
36.	<i>Colutea orientalis</i> Mill.	+		+
37.	<i>Cotoneaster horizontalis</i> Decne.	+		+
38.	<i>Cotoneaster melanocarpus</i> Load.	+		+
39.	<i>Crataegus monogyna</i> Jacq.	+		+
40.	<i>Cydonia oblonga</i> Mill.	+		+
41.	<i>Diospyros lotus</i> L.	+		+
42.	<i>Elaeagnus angustifolia</i> L.	+		+
43.	<i>Eriobotrya japonica</i> Lindl.	+		+
44.	<i>Euonymus japonicus</i> L.	+		+

45.	<i>Eucalyptus leucoxylon</i> F.Muell.	+		+
46.	<i>Eucalyptus camaldulensis</i> Dehn.	+		+
47.	<i>Ficus carica</i> L.	+		+
48.	<i>Ficus hyrcana</i> A. Grossh.	+		+
49.	<i>Fraxinus excelsior</i> L.	+		+
50.	<i>Fraxinus velutina</i> Torr.	+		+
51.	<i>Fraxinus malocophulla</i> Hemsl.	+		+
52.	<i>Gleditsia triacanthos</i> L.	+		+
53.	<i>Hedera colchica</i> C.Koch.		+	+
54.	<i>Hedera helix</i> L.		+	+
55.	<i>Hydrangea paniculata</i> Sieb.	+		+
56.	<i>Hibiscus syriacus</i> L.	+		-
57.	<i>Jasminum nudiflorum</i> Lindl.	+		+
58.	<i>Juglans regia</i> L.	+		+
59.	<i>Laurus nobilis</i> L.	+		-
60.	<i>Lonicera japonica</i> Thunb.	+		+
61.	<i>Lonicera caucasica</i> Pall.	+		+
62.	<i>Lonicera caprifolium</i> L.	+		+
63.	<i>Ligustrum japonicum</i> Thunb.		+	+
64.	<i>Ligustrum vulgare</i> L.	+		+
65.	<i>Maclura pomifera</i> (Raf.) Sjh.	+		+
66.	<i>Magnolia grandiflora</i> L.	+		-
67.	<i>Malus domestica</i> Borkh.	+		+
68.	<i>Malus silvestris</i> Mill.	+		+
69.	<i>Mahonia aquifolium</i> Nutt.		+	-
70.	<i>Melia azedarach</i> L.	+		+
71.	<i>Mespilus germanica</i> L.	+		+
72.	<i>Morus alba</i> L.	+		+
73.	<i>Morus nigra</i> L.	+		+
74.	<i>Morus rubra</i> L.	+		+
75.	<i>Nerium oleander</i> L.	+		+
76.	<i>Olea europaea</i> L.	+		+
77.	<i>Parrotia persica</i> (DC.) C.A. Mey.	+		+
78.	<i>Platanus orientalis</i> L.	+		+
79.	<i>Pittosporum tobira</i> Dryand.	+		+
80.	<i>Populus euphratica</i> Olivier.	+		+
81.	<i>Populus hyrcana</i> Grossh.	+		+
82.	<i>Phoenix dactylifera</i> L.	+		-
83.	<i>Prunus armeniaca</i> L.	+		+
84.	<i>Prunus padus</i> L.	+		+
85.	<i>Prunus dulcis</i> Mill.	+		+
86.	<i>Prunus persica</i> (L.)Batsch	+		+
87.	<i>Prunus domestica</i> L.	+		+
88.	<i>Pyrus communis</i> L.	+		+
89.	<i>Pyrus salicifolia</i> Pall.	+		+
90.	<i>Pyrus caucasica</i> Fed.	+		+
91.	<i>Pyracantha coccinea</i> Roem.	+		+
92.	<i>Quercus castaneifolia</i> J.A.Mey.	+		+

93.	<i>Quercus ilex</i> L.	+		+
94.	<i>Quercus iberica</i> Stev.	+		+
95.	<i>Quercus macranthera</i> Fisch. M.	+		+
96.	<i>Rhamnus alaternus</i> L.	+		+
97.	<i>Robinia pseudoacacia</i> L.	+		-
98.	<i>Rosmarinus officinalis</i> L.	+		+
99.	<i>Salix caprea</i> L.	+		+
100.	<i>Salix babylonica</i> L.	+		+
101.	<i>Sophora japonica</i> L.	+		+
102.	<i>Spiraea vanhouttei</i> (Briot) Zbl	+		-
103.	<i>Syringa vulgaris</i> L.	+		+
104.	<i>Tamarix tetrandra</i> Pall.	+		+
105.	<i>Tecoma radicans</i> Seem.	+		+
106.	<i>Trachycarpus excelsa</i>	+		-
107.	<i>Tilia caucasica</i> Rupr.	+		+
108.	<i>Ulmus parvifolia</i> Jacq.	+		+
109.	<i>Ulmus minor</i> Mill.	+		+
110.	<i>Viburnum tinus</i> L.Hemsl.	+		+
111.	<i>Vitex negundo</i> L.	+		+
112.	<i>Vitis sylvestris</i> Gmel.	+		+
113.	<i>Yucca aloifolia</i> L.	+		+
114.	<i>Washingtonia filifera</i> H.Wendl.	+		-
115.	<i>Zelkova carpinifolia</i> (Pall.) K.Koch.	+		+

The leaves are small and simple, the veins are thin and hairy. Flowering and fruiting are high in this type of plant species, they have late blooming leaves and early flowering [Kurbanov, 2004; Molchanov & Smirnov, 1967]. These plants are resistant to heat and drought. Among the studied plants with the above-mentioned characteristics, *Juniperus sabina*, *Pinus halepensis*, *Pinus eldarica*, *Abelia grandiflora*, *Acacia dealbata*, *Berberis thunbergii*, *Berberis vulgaris*, *Celtis caucasica*, *Cercis siliguastrum*, *Colutea arborescens*, *Colutea orientalis*, *Cydonia oblonga*, *Elaeagnus angustifolia*, *Gleditsia triacanthos*, *Populus euphratica*, etc. types can be shown.

Abelia grandiflora, *Albizia julibrissin*, *Berberis thunbergii*, *Broussonetia papyrifera*, *Catalpa bignonioides*, *Ficus hyrcana*, *Melia azedarach*, etc. growing in a shady place. As a result of the observations on the species, showed that the development of these plants is weakened, including a decrease in the percentage of flowering, an increase in the number of side branches, and thinning of the

leaves.

During the research work, it was determined that *Taxus baccata*, *Taxus cuspidata*, *Buxus sempervirens*, *Acer pseudoplatanus*, *Acer laetum*, *Carpinus betulus*, *Castanea sativa*, *Hedera colchica*, *Ligustrum japonicum*, etc. In such species, the formation of burns on the leaves of those plants on hot summer days and delays in growth and development are observed. From this point of view, when introducing plants to new conditions, it would be more correct to plant them in places according to ecological requirements.

Then, while studying the resistance to wind of the studied plants, it was found that 18 types of these plants are resistant to wind and 97 types are unresistant to wind. The results of the phenological observations showed that the wind generally affects all studied plant species to one degree or another. However, in the 18 wind-resistant taxa listed in Table 2, growth and development were weakened by wind, deformations in their morphological organs, and changes in their natural forms.

It is known that water has a special importance in the growth and development of plants, as well as in the formation of vegetation from an ecological point of view.

In order to understand the ecological importance of water to plants, it is important to know the water needs of the plant species, water source, water uptake and water evaporation by the plants, and their classification according to their water needs.

In this regard, we tried to study the division of plants studied in the study area into groups according to their water requirements.

The plants studied by us are divided into 5 different groups according to their need for water.

The results of the analyzes showed that 2 of the studied species are hygrophytes, 56 are mesophytes, 23 are xerophytes, 9 are mesoxerophytes, and 25 species are included in the xeromesophyte group (table 3.).

Among the studied plants, 2 species *Eucalyptus leucoxylon* and *Eucalyptus camaldulensis*

were included in the group of hygrophytes - i.e. living in moist places. These plants are naturally distributed in humid regions.

As can be seen from Table 3, the mesophyte group (with moderate water needs) includes 56 plant species (*Abelia grandiflora*, *Acer pseudoplatanus*, *Taxus baccata*, *Thuja orientalis*, *Acer laetum*, *Berberis thunbergii*, *Berberis vulgaris*, *Catalpa bignonioides*, *Albizia julibrissin*, *Diospyros lotus*, *Carpinus betulus*, etc.), the root system and other morphological organs are well developed in the plants included in this group.

It was found out from the analyzes that 23 species (*Cupressus sempervirens*, *Cupressus arizonica*, *Pinus eldarica*, *Pinus halepensis*, *Celtis caucasica*, *Cercis siliguastrum*, *Colutea arborescens*, *Elaeagnus angustifolia*, *Nerium oleander*, *Rosmarinus officinalis*, etc.) belong to the xerophyte group (which needs less water). entered. As a result of our observations, it became clear that these plants are naturally distributed in arid regions.

Table 3.
Woody plants in ex situ conditions distribution according to the need for water

№	SPECIES	GROUPS				
		HYGROPHYTE	MESOPHYTE	XEROPHYTE	MESOXEROPHYTE	XEROMESOPHYTE
1	2	3	4	5	6	7
PINOPHYTA						
1.	<i>ABIES NORDMANNIANA</i> SPACH.		+			
2.	<i>CEDRUS LIBANI</i> A.RICH.					+
3.	<i>CUPRESSUS SEMPERVIRENS</i> L.			+		
4.	<i>CUPRESSUS SEMPERVIRENS</i> L. FOR. <i>HORIZONTALIS</i> (MILL). GORD.			+		
5.	<i>CUPRESSUS SEMPERVIRENS</i> L. FOR. <i>PYRAMIDALIS</i> TARG.			+		
6.	<i>CUPRESSUS ARIZONICA</i> GREENE.			+		
7.	<i>CUPRESSUS X LEYLANDII</i>				+	
8.	<i>JUNIPERUS COMMUNIS</i> L.					+
9.	<i>JUNIPERUS SABINA</i> L.					+
10.	<i>PINUS ELДАРICA</i> MEDW.			+		
11.	<i>PINUS HALEPENSIS</i> MILL.			+		
12.	<i>PINUS PINEA</i> L.			+		

13.	<i>TAXUS BACCATA</i> L.		+			
14.	<i>TAXUS CUSPIDATA</i> SIEB. ET. ZUCC.		+			
15.	<i>THUJA ORIENTALIS</i> L.		+			
MAGNOLIOPHYTA						
16.	<i>ABELIA GRANDIFLORA</i> REHD.		+			
17.	<i>ACACIA DEALBATA</i> LINK.					+
18.	<i>ACER CAMPESTRE</i> L.		+			
19.	<i>ACER VELUTINUM</i> BOISS.			+		
20.	<i>ACER PSEUDOPLATANUS</i> L.		+			
21.	<i>ACER LAETUM</i> C.A. MEY.		+			
22.	<i>AGAVE AMERICANA</i> L.					+
23.	<i>AILANTHUS ALTISSIMA</i> (MILL.) SWINGLE.					+
24.	<i>ALBIZIA JULIBRISSIN</i> DURAZZ.		+			
25.	<i>BERBERIS THUNBERGII</i> DC.		+			
26.	<i>BERBERIS VULGARIS</i> L.		+			
27.	<i>BUXUS SEMPERVIRENS</i> L.					+
28.	<i>BROUSSONETIA PAPYRIFERA</i> (L.) VENT.					+
29.	<i>CATALPA BIGNONIODES</i> WALT.		+			
30.	<i>CARPINUS BETULUS</i> L.		+			
31.	<i>CASTANEA SATIVA</i> MILL.		+			
32.	<i>CELTIS CAUCASICA</i> WILLD.			+		
33.	<i>CERCIS SILIGUASTRUM</i> L.			+		
34.	<i>CORNUS MAS</i> L.				+	
35.	<i>COLUTEA ARBORESCENS</i> L.			+		
36.	<i>COLUTEA ORIENTALIS</i> MILL.			+		
37.	<i>COTONEASTER HORIZONTALIS</i> DECNE.				+	
38.	<i>COTONEASTER MELANOCARPUS</i> LOAD.		+			
39.	<i>CRATAEGUS MONOGYNA</i> JACQ.				+	
40.	<i>CYDONIA OBLONGA</i> MILL.		+			
41.	<i>DIOSPYROS LOTUS</i> L.		+			
42.	<i>ELAEAGNUS ANGUSTIFOLIA</i> L.			+		
43.	<i>ERIOBOTRYA JAPONICA</i> LINDL.		+			
44.	<i>EUONYMUS JAPONICUS</i> TUNB.		+			
45.	<i>EUCALYPTUS LEUCOXYLON</i> F. MUELL.	+				
46.	<i>EUCALYPTUS CAMALDULENSIS</i> DEHN.	+				
47.	<i>FICUS CARICA</i> L.					+
48.	<i>FICUS HYRCANA</i> A. GROSSH.				+	
49.	<i>FRAXINUS EXCELSIOR</i> L.		+			
50.	<i>FRAXINUS VELUTINA</i> TORR.		+			
51.	<i>FRAXINUS MALOCOPHULLA</i> HEMSL.		+			
52.	<i>GLEDITSIA TRIACANTHOS</i> L.		+			
53.	<i>HEDERA COLCHICA</i> C. KOCH.		+			
54.	<i>HEDERA HELIX</i> L.		+			
55.	<i>HYDRANGEA PANICULATA</i> SIEB		+			
56.	<i>HIBISCUS SYRIACUS</i> L.		+			
57.	<i>JASMINUM NUDIFLORUM</i> LINDL.		+			
58.	<i>JUGLANS REGIA</i> L.		+			
59.	<i>LAURUS NOBILIS</i> L.				+	

60.	<i>LIGUSTRUM JAPONICUM</i> THUNB.					+
61.	<i>LIGUSTRUM VULGARE</i> L.					+
62.	<i>LONICERA JAPONICA</i> THUNB.		+			
63.	<i>LONICERA CAUCASICA</i> PALL.		+			
64.	<i>MACLURA POMIFERA</i> (RAF.) SJHN.					+
65.	<i>MAGNOLIA GRANDIFLORA</i> L.		+			
66.	<i>MESPILUS GERMANICA</i> L.		+			
67.	<i>MALUS DOMESTICA</i> BORKH.		+			
68.	<i>MALUS SILVESTRIS</i> MILL.		+			
69.	<i>MAHONIA AQUIFOLIUM</i> NUTT.		+			
70.	<i>MELIA AZEDARACH</i> L.		+			
71.	<i>MORUS ALBA</i> L.					+
72.	<i>MORUS NIGRA</i> L.		+			
73.	<i>MORUS RUBRA</i> L.		+			
74.	<i>NERIUM OLEANDER</i> L.			+		
75.	<i>OLEA EUROPAEA</i> L.					+
76.	<i>PADUS MAHALEB</i> BORKH.				+	
77.	<i>PARROTIA PERSICA</i> (DC.) C.A. MEY.		+			
78.	<i>PLATANUS ORIENTALIS</i> L.		+			
79.	<i>PITTOSPORUM TOBIRA</i> DRYAND.		+			
80.	<i>POPULUS HYRCANA</i> GROSSH.		+			
81.	<i>POPULUS EUPHRATICA</i> OLIVIER.				+	
82.	<i>PHOENIX DACTYLIFERA</i> L.		+			
83.	<i>PRUNUS ARMENIACA</i> L.				+	
84.	<i>PRUNUS PADUS</i> L.					+
85.	<i>PRUNUS DULCIS</i> MILL.					+
86.	<i>PRUNUS PERSICA</i> (L.) BATSCH		+			
87.	<i>PRUNUS DOMESTICA</i> L.		+			
88.	<i>PYRUS COMMUNIS</i> L.		+			
89.	<i>PYRUS SALICIFOLIA</i> PALL.			+		
90.	<i>PYRUS CAUCASICA</i> FED.			+		
91.	<i>PYRACANTHA COCCINEA</i> ROEM.		+			
92.	<i>QUERCUS CASTANEIFOLIA</i> J.A.MEY.			+		
93.	<i>QUERCUS ILEX</i> L.			+		
94.	<i>QUERCUS IBERICA</i> STEV.			+		
95.	<i>QUERCUS MACRANTHERA</i> FISIH. M.			+		
96.	<i>RHAMNUS ALATERNUS</i> L.					+
97.	<i>ROBINIA PSEUDOACACIA</i> L.					+
98.	<i>ROSMARINUS OFFICINALIS</i> L.			+		
99.	<i>SALIX CAPREA</i> L.		+			
100.	<i>SALIX BABYLONICA</i> L.		+			
101.	<i>SOPHORA JAPONICA</i> L.					+
102.	<i>SPIRAEA VANHOUTTEI</i> (BRIOT) ZBL		+			
103.	<i>SYRINGA VULGARIS</i> L.					+
104.	<i>TAMARIX TETRANDBRA</i> PALL.			+		
105.	<i>TECOMA RADICANS</i> SEEM.		+			
106.	<i>TILIA CAUCASICA</i> RUPE.		+			
107.	<i>TRACHYCARPUS EXCELSA</i> HORT.					+

108.	<i>ULMUS PARVIFOLIA</i> JACQ.					+
109.	<i>ULMUS MINOR</i> MILL. GILBERT.					+
110.	<i>VIBURNUM TINUS</i> L. HEMSL.		+			
111.	<i>VITEX NEGUNDO</i> L.					+
112.	<i>VITIS SYLVESTRIS</i> GMEL.		+			
113.	<i>YUCCA ALOÏFOLIA</i> L.			+		
114.	<i>WASHINGTONIA FILIFERA</i> H. WENDL.					+
115.	<i>ZELKOVA CARPINIFOLIA</i> (PALL.) K. KOCH.		+			

In general, unlike the plants included in the mesophytic group, the signs of adaptation to the conditions in which they grow in xerophytic plants are divided into two parts. Therefore, in xerophytic plants, the root system, including the spindle root, develops well, the leaves shrink or change their shape, and the leaves are covered with a layer of wax or hairs.

The results of the analyzes showed that 9 species (*Cotoneaster horizontalis*, *Prunus armeniaca*, *Tamarix tetrandra*, *Populus euphratica*, *Padus mahaleb*, etc.) were included in the mesoxerophyte group. In addition to being resistant to drought, the plants included in this group have certain requirements for water.

It was known that 25 species (*Ailanthus altissima*, *Vitex negundo*, *Ulmus minor*, *Syringa vulgaris*, *Robinia pseudoacacia*, *Sophora japonica*, etc.) are included in the xeromesophyte group. The species included in this group are more resistant to drought than the mesoxerophytic species. The results of the phenological observations showed that no damage was seen in their morphological organs in the hot summer months.

The results of the research showed that the studied trees and shrubs have different ecological needs according to their water requirements, and can be widely used in the greening of cities and towns of different regions according to their wishes.

Conclusion

1. The cultural dendroflora of the research area is 101 light-loving, 14 shade-loving, 97 wind unresistant, and 18 wind-resistant plants according to their ecological relationship to light, 56 types of mesophyte, 23 types of xerophyte, 9 types of mesoxerophyte, 25 types of xeromesophyte, and 2 types of hygrophyte. was found to be organized.

2. When studying the one-day temperature changes of the studied plants at different heights from the soil surface, depending on the species, it was found that the temperature in the area closest to the soil surface is between 26-32°C, and the temperature at the height from the soil surface to the top of the plant, from the area close to the soil surface It was known that 4-7°C is less

Recommendations

In order to increase the degree of introduction of tree and shrub plants to be used in cultural conditions, taking into account their in situ bioecological characteristics and historical background, collecting and mobilizing planting and sowing material from fertile individuals of different geographical origins with different geno- and phenotypic indications in their natural habitat is more important. is appropriate.

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PHYTOCENOLOGICAL CHARACTERISTICS OF THE WOODY SPECIES OF THE ROSACEAE FAMILY IN THE MOUNTAIN-XEROPHYTE AND STEPPE VEGETATION OF NAKHCHIVAN AR

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Abstract: *In the presented article, woody species belonging to the Rosaceae family spreading in the mountain-xerophytic and steppe vegetation of Nakhchivan Autonomous Republic were studied, and these species were divided into 4 classes according to the groupings they formed in the shrub vegetation of the region. Also, in the article 50% the dominant, 10% co-dominant species and other species participating in the grouping belonging to each class were evaluated as assessors and the information about them was also reflected. Numerous studies have also made it possible to determine the important features characteristic of the woody species of the Rosaceae family in each of these classes. In our researches, 4 formation classes, 13 formations, 39 associations and 12 subassociations formed by the woody species of the Rosaceae family spreading in the flora of the Nakhchivan Autonomous Republic in the mountain-xerophyte and steppe vegetation were determined and a phytocenological classification of the vegetation was given. For the first time, subassociation was used as a unit in vegetation.*

Keywords: *phytocenosis, steppe, formation, association, subassociation*

Introduction

The fact that the territory of the Nakhchivan Autonomous Republic has a rich flora and colorful vegetation is related to the diversity of its physical-geographic and natural-historical conditions, as well as its complex history formed under the influence of large floristic areas. Numerous studies have been conducted to study the structure, composition and dynamics of the vegetation of the region. Mountain-xerophyte vegetation often merges with steppes and forms special formations. In the formation of mountain-xerophyte and steppe vegetation, shrub plants, especially woody species of the *Rosaceae* family play a key role.

Shrub groups are found in all landforms, on the slopes and valleys of river valleys, in rocky and escarpment areas, in forest-fringed thickets, and in high mountain steppes. Considering the relevance of the topic, it is considered important to conduct research in

this direction.

Material and methodology of the research

Since 2019, the study of woody species of the *Rosaceae* family spread in the territory of Nakhchivan AR has been started. Woody species of the *Rosacea* family always form different groups. [Alekhin, 1950; Yaroshenko, 1967; Bykov, 1909; Lavrenko, 1982; Prilipko, 1939, 1970; Ibrahimov, 2007]. In defining subassociations, [Alekhin, 1950; Poplavskoy, 1948; Vysochsky 1909] etc. works of researchers, [Sukachev 1942; 1945; 1975] methods were taken as a basis.

Discussion and conclusions of the study

It is considered appropriate to study woody species belonging to the *Rosaceae* family spreading in the mountain-xerophyte and steppe vegetation of Nakhchivan Autonomous Republic, as well as to determine

the role of these species in the composition of the shrub vegetation of the region. The shrub vegetation of the studied area is divided into 4 classes according to the groups they form. Also, within these classes, the formation,

association and sub-associations given by us for the first time, and the *Rosaceae* family formed by the woody species, were studied. These classes are grouped as follows

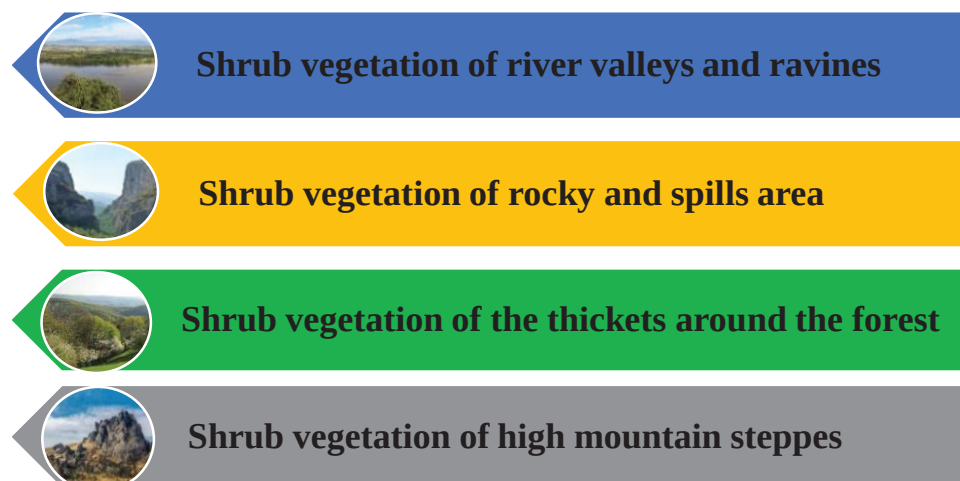


Diagram 1. Shrub vegetation type of the studied area

In the structure of the mountain-xerophyte and steppe complex, trees and shrubs, especially woody species of the *Rosaceae* family, occupy an important place. These plants are part of the bush steppes, form independent groups and form unique formations. During the study, the separation of formations in the shrub vegetation was carried out according to the superior species that make up the main layer (solid, layer). In order to reflect the dynamic processes within associations in plant groups, sub-associations were found and differentiated. Subassociations are defined on the basis of the secondary subdominants included in the association, and a different ecological variant of the association is taken as the basis, which is the taxonomic unit within the association.

In our research, it was determined that the woody species of the *Rosaceae* family were never evenly spread on the banks of rivers and streams. The river valleys of Nakhchivanchay, Alincehay, Havushchay, Gilanchay and Arpachay, as well as Julfa, Ordubad, Sharur and Shahbuz regions were studied as research objects. As a result of the increase of snow and rainwater in summer months, the increase of the water level in the

rivers had a strong effect on the riverside phytocenoses, and sometimes it caused the areas and the phytocenoses to be washed away.

The composition of these phytocenoses is enriched with woody species such as *Crataegus caucasica*, *C. meyeri*, *Cotoneaster integerrimus*, *C. melanocarpus*, *Prunus microcarpa*, *P. divaricata*, *Pyrus salicifolia*, *Rosa canina*, *R. karjaginii*, *Rubus ibericus* belonging to the family of flowering plants. In our research, it was determined that representatives of the *Rosaceae* family form the basis of the shrub vegetation in the studied areas (Figure 1).

Chamaenerion angustifolium, *Achillea millefolium*, *A. biebersteinii*, *Euphorbia iberica*, *Carex leporina*, *C. vesicaria*, *C. transcaucasica*, *Heracleum pastinacifolium*, *H. trachyloma*, *Equisetum arvense*, *E. palustre* and species such as *Mentha aquatica* enrich the composition of the phytocenosis.

In this studied class of vegetation, 6 formations, 13 associations and 1 sub-association were identified for the first time and a phytocenological classification of vegetation was given.

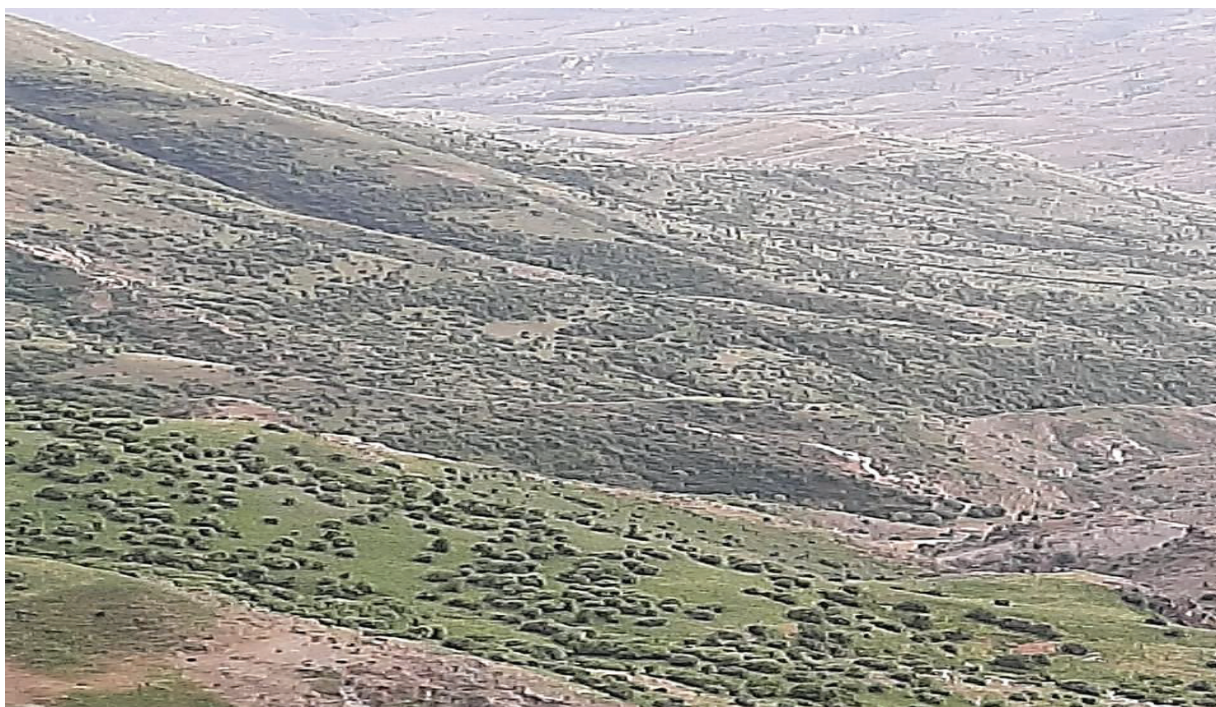


Fig. 1. Phytocenoses of ravine banks

Based on our researches, we determined that the composition of the vegetation of the rocky and spills areas is almost qualitatively and quantitatively different from each other. That is why, as a result of the research, it is considered appropriate to study 2 groups, namely the bushes of the rocky areas and the bushes of the outcrops.

Along with *Rosa canina*, *R. sosnovskyana*, *R. iberica*, *R. corymbifera*, *Crataegus orientalis*, *C. pseudoheterophylla*, *C. caucasica*, *C. cinovskis*, which belong to the *Rosaceae* family, *Juniperus foetidissima*, *J. polycarpus*, mainly *J. communis* species are also common.

Spills are formed due to various natural causes and as a result of accumulation of imported materials in certain areas. Sometimes quite dense thickets of trees and shrubs belonging to the *Rosaceae* family are formed in the soil areas at the foot and on the edges of the spills. Often there are groups formed by *Spiraea crenata* and *S. hypericifolia* species.

In this studied vegetation class, 2 formations, 7 associations and 7 sub-associations were determined and phytocenological classification was given [Ganbarov & Babayeva, 2022].

Shrubs around the forest are considered

to be the most common areas of the *Rosaceae* family. In forest-shrub areas, both components are generally in direct contact, and there is also a kind of "introduction" dynamic between forest and shrub. Representatives of this family are considered to be the founder builders of the forest surrounding bushes (Fig. 2.).

Ecologically, area plants are composed of mesophyte, mesoxerophyte and xerophyte elements. We have also noted that these areas are characterized by the richness of species composition of herbaceous plants. Thus, 2 formations, 6 associations and 3 sub-associations were studied by us in the forest surrounding bushy areas.

High mountain steppe vegetation has been studied mainly by dividing into two groups, typical mountain steppes and high mountain meadows. High mountain steppes cover large areas in the study area and form a zone. The species composition of the groups formed in the high mountain steppes is quite diverse and is characterized by the complete dominance of various herbs. Regardless of the location, high mountain steppe plants in all areas are constantly in contact with woody plants of the *Rosaceae* family and form different groups (Table 2).



Fig. 2. Phytocenosis of forest-fringed shrubs

Table 1.

Species composition of the shrub vegetation of the spills

No	Names of the species	Abundance	Height by sm.	Phenophaze (blossom-fruit)	Leyer
1	2	3	4	5	6
1	<i>C. cinovskissi</i>	1	1000	V-IX	I
2	<i>C. meyeri</i>	1-3	300-400	V-VI, IX-X	I
3	<i>C. caucasica</i>	1	700-800	V-VIII, X	I
4	<i>C. orientalis</i>	1-2	300-400	V-VI-VII, IX-X	I
5	<i>C. szovitsii</i>	2	300-500	V-IX	I
6	<i>Cotoneaster melanocarpus</i>	2-3	100-200	VI-VII, VII-IX	II
7	<i>C. multiflorus</i>	2	150-200	V-VI, VII-VIII	II
8	<i>Pyrus nutans</i>	1-2	1000-1500	IV-V, VII-IX	I
9	<i>P. salicifolia</i>	1	800-1000	IV-IX	I
10	<i>P. oxyprion</i>	1	800-1000	IV-IX	I
11	<i>P. microcarpa</i>	1-2	200	IV-V	II
12	<i>P. divaricate</i>	3-4	300-400	III-IV, VII-VIII	I
13	<i>Spiraea crenata</i>	3-5	100	IV-V, VI-VII	III
14	<i>S. hypericifolia</i>	2-4	150	V-VI, VII-VIII	II
15	<i>Lonicera iberica</i>	1-2	2000-3000	V-VII, IX	I
16	<i>Quercus macranthera</i>	1	1000-1500	IV-X	I
17	<i>Aethionema pulchellum</i>	2-3	10-30	V-VI	IV
18	<i>Centaurea squarrosa</i>	1-2	25-50	VI, VIII-VII, IX	IV
19	<i>C. glehnii</i>	2	25-50	VI, VII-VII, VIII	IV
20	<i>Teucrium orientale</i>	2-3	20-50	V-VII, VII-IX	IV
21	<i>Pyrethrum myriophyllum</i>	2-3	20-30	VI, VII-VII, VIII	IV
22	<i>Crupina crupinastrum</i>	1	20-80	V-IX	III

23	<i>Echinops sphaerocephalus</i>	2-3	50-70	VI-IX	III
24	<i>Scabiosa bipinnata</i>	2	10-40	VI, VIII-VIII, IX	IV
25	<i>Bupleurum exaltatum</i>	1-2	40-70	VII, VIII-IX	III
26	<i>Scutellaria araxensis</i>	1-2	20-30	V, VI-VI, VII	IV
27	<i>Scrophularia variegata</i>	1-2	20-40	V, VII-VI, VII	IV
28	<i>Galium verum</i>	2	30-120	VI-IX	III
29	<i>Dactylis glomerata</i>	2-3	30-60	V-VII	III
30	<i>Helichrysum plicatum</i>	1-3	8-40	VI, VII-VII, VIII	IV
31	<i>Medicago sativa</i>	2	20-80	V-VII	III
32	<i>Aethionema pulchellum</i>	1-3	10-30	V-VI	IV
33	<i>Eryngium billardieri</i>	2-3	60-70	VI, VII-VII, IX	III
33	<i>Calamagrostis epigeios</i>	1-2	60-150	VI-VIII	II
35	<i>C. arundinacea</i>	1	60-130	VI-VIII	II

Table 2.

Species composition of high mountain steppes

No	Names of the species	Abundance	Height by sm.	Phenophase (blossom-fruit)	Leyer
1	2	3	4	5	6
1	<i>Prunus divaricate</i>	3-4	300-400	III-IV, VII-VIII	I
2	<i>Crataegus meyeri</i>	3-5	300-400	V-VI, IX-X	I
3	<i>Spiraea crenata</i>	1-2	100	IV-V, VI-VII	II
4	<i>S. hypericifolia</i>	1	150	V-VI, VII-VIII	II
5	<i>Cotoneaster integerrimus</i>	2-3	150	VI-VII, VIII-IX	II
6	<i>C. melanocarpus</i>	1-3	100-200	VI-VII, VII-IX	II
7	<i>C. multiflorus</i>	1-2	150-200	V-VI, VII-VIII	II
8	<i>C. suavis</i>	1	40-100	V-VI	III
9	<i>C. saxatilis</i>	1	150-175	IX-X	II
10	<i>Sorbus persica</i>	1	200-270	V-VI, IX	II
11	<i>S. boissieri</i>	1	600-800	V-IX	I
12	<i>S. graeca</i>	1-2	200	V-VI, VII-IX	II
13	<i>S. luristanica</i>	1	200-250	V-VI, IX	II
14	<i>S. roopiana</i>	1	200-300	V-IX	II
15	<i>S. turcica</i>	1	250-270	V, VII-IX	II
16	<i>Malus orientalis</i>	2-3	600-800	IV-V, VII-X	I
17	<i>Rosa haemisphaerica</i>	1-2	100-200	VI-VII	II
18	<i>R. karjagii</i>	1-2	50-60	VI-VII	III
19	<i>R. iberica</i>	2	70-110	V-VI	II
20	<i>R. hraciana</i>	1-2	80-100	V-VI	III
21	<i>R. kazarjanii</i>	1	80-100	V-VI	III
22	<i>R. marschalliana</i>	1	120	VI-VII	II
23	<i>R. pimpinellifolia</i>	2-3	75	V-VI	III
24	<i>Stipa pulcherrima</i>	2-3	40-100	V, VI-VII	III
25	<i>Stipa capillata</i>	2-4	20-70	VII-VIII	III
26	<i>S. holosericea</i>	1-3	40-100	V-VI	III
27	<i>Calamagrostis arundinacea</i>	2	60-130	VI-VIII	III
28	<i>Aster alpinus</i>	1-2	5-25	VII-IX	IV
29	<i>Stachys macrantha</i>	1-2	20-50	VI-VIII	IV

30	<i>Primula macrocalyx</i>	2-3	15-35	IV-VI	IV
31	<i>Myosotis alpestris</i>	3-5	10-30	V-VII	IV
32	<i>Filipendula vulgaris</i>	2-3	30-60	V, VI-VIII	III
33	<i>Carex vesicaria</i>	1-3	50-60	VII-VIII	III
34	<i>Bromopsis riparia</i>	2-3	30-70	VI-VIII	III
35	<i>Koeleria cristata</i>	2-3	20-40	V-VIII	IV
36	<i>Pyrethrum parthenifolium</i>	1-3	40-70	VI-VIII	III
37	<i>Pulsatilla albana</i>	1-3	5-15	V-VII	IV
38	<i>Teucrium chamaedrys</i>	1-3	10-45	V, VIII-VII, IX	IV
39	<i>T. polium</i>	2	15-30	V-VIII	IV
40	<i>Scutellaria platystegia</i>	1-3	25	V, VII-VII	IV
41	<i>Prangos ferulacea</i>	3-5	100	V, VI-VII, VIII	III
42	<i>Astragalus lagurus</i>	3-4	40	VII	IV
43	<i>Thymus kotschyanus</i>	3-4	10-15	VI-VII	IV
44	<i>T. collinus</i>	1-2	10-20	VI, VII-VII	IV

3 formations, 13 associations and 1 sub-association were identified in the class of shrub vegetation of the high mountain steppes for the first time, and a phytocenological classification of the vegetation was given.

Conclusion

As a result of our research, for the first time, 4 formation classes, 13 formations, 39

associations and 12 subassociations formed by the woody species of the *Rosaceae* family in the mountain-xerophyte and steppe vegetation were determined and a phytocenological classification of the vegetation was given. Also, for the first time, subassociation was used as a unit in vegetation.

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BIOECOLOGICAL CHARACTERISTICS OF THE *CHENOPODIACEAE* FAMILY FOUND IN THE MOUNTAIN RANGE OF DASHKASAN REGION**AYNUR BAYRAMOVA**

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Abstract: Conservation of biological diversity is the greatest challenge of our modern life and an important task of biological science. Conservation of biological diversity is the most important issue in conducting floristic research in different areas. In this regard, the subject is relevant from the point of view of the distribution of the species belonging to the *Chenopodiaceae* family found in the mountain range of Dashkasan region in a florogenetically regular manner, as well as the assessment of biodiversity and the development of measures for its protection. 11 species belonging to 7 genera of *Chenopodiaceae* family were found. During the study, ecological analyzes were carried out on species against environmental factors, probably the most important for the studied taxon are: 1) presence of humidity, 2) salinization of habitats, 3) mechanical composition of habitats, 4) anthropogenic factors. The main goal is to take into account the habitats of the species in nature and some morphophysiological characteristics of the species, to determine the degree of importance of the indicated factors and their relationship with each other. Taking into account the ratio of the environment in the area, the degree of synanthropization of the family *Chenopodiaceae* was determined. The percentage of synanthropic species is relatively high.

Keywords: *Chenopodiaceae*, family, genus, species, synanthropus, edificator

Introduction: The species belonging to *Chenopodiaceae* Vent family are systematically and diagnostically complex and are characterized by an active speciation process. The species distributed mainly in the area occupy a special place in the flora of Dashkasan region mountain system. A number of representatives act as edificators and sub-edificators and play an important role in the composition of vegetation. Ecological factors in nature are closely related to each other, they affect all plants in a complex way, depending on the place of residence.

The degree of anthropogenic influence of the highland part of Dashkasan region is characterized by intensive human influence compared to the flat areas of the lower and middle mountain belt. The analysis of life forms is given according to the Raunkier system. Analyzing the current status of some

taxa, for example, *Salsola nodulosa*, which is a subendemic species, requires special attention and conservation measures in natural conditions due to its limited habitats and distribution.

According to geographical elements, it is characterized by ancient Mediterranean, Caucasian and Polyarctic floristic elements. Some species are endemic and relict. Due to increased human impact on the environment, the environment for the flora of the region is being eaten away by "easy weed eater" and synanthropic organisms. Anthropogenic transformation of biotopes leads to the extinction of many species. The representatives of the family distributed in arid areas are of great economic importance as a fodder plant, and are also used as a medicinal plant and raw fuel for dye [Bayramova, 2013; Gurbanov, 2009; Portenier, 2000].

Material and methodology: Researches were carried out in the main areas of Dashkasan region mountain range. The Dashkasan mountain system is located within the orogenic belt. The herbarium of some of the species belonging to the family *Chenopodiaceae* has been collected. During the research, the main methods were chosen: classical, comparative-morphological, ecological-geographic and biomorphological [Braun-Blanquet, 1937; Zozulin, 1506-1514; Abstract of the flora of the Caucasus. 2003, 2006, 2008; Portenier, 2000]. When compiling the article, the place of occurrence of the species and floristic areas were taken into account.

Biomorphs in biological landfills were selected as test objects. It is possible to identify and predict successions occurring in agroecosystems through test facilities [Zozulin, 1506-1514.].

Relevance of the topic: Dashkasan region is located in the northeastern part of the Lesser Caucasus at an altitude of 1600-1800 meters above sea level. Dashkasan district is surrounded by the slopes of Murov dag and Shahdag mountain ranges to the north. The highest peaks are Hinaldag (3367 m) and Murovdag (3361 m). Jurassic and Cretaceous sediments are spread in the area. The relief of the zone has larger forms. The river valleys here are relatively large. Mainly from Mesozoic and Tertiary volcanogenic rocks, sedimentary

rocks to limestones and clay shales, etc. is encountered. Since these rocks are easily eroded, soil and vegetation grow well on them.

It should be noted that the systematic structure of the flora is also affected by the structure of the landscape. Due to the complexity of the relief and the influence of other natural factors, the flow is not evenly distributed over the area. The flow modulus in the area generally increases with height.

In some areas, 11 species belonging to 7 genera of *Chenopodiaceae* family were found based on preliminary survey in wet meadows, river banks and high mountain ranges. As a result of analysis at the genus level, the amount of *Anabasis* (1), *Hablitzia* (1), *Kochia* (1), *Salsola* (3), *Noaea* (1), *Chenopodium* (2), *Atriplex* (2) species was determined. The species of *Salsola* (3), *Chenopodium* (2), *Atriplex* (2) genera are widespread. *Chenopodiaceae* Vent belonging to the family of flowering plants was found in the area. Each type is described below.

Genus *Anabasis* L.

A.aphylla L., Sp.Pl.,223(1753).- Leafless a.

It's a bush. Nanophanerophyte, height 35-60 cm. flowering V-VIII. It is found in the lower and middle mountain belt, in wet meadows, on the banks of rivers. Palearctic. (Pl.) The species is described from the Caucasus (Caspian coast). Described from Southwest (Iran), Central Asia (Fig. 1).



Figure 1. *Anabasis aphylla* L.



Figure 2. *Kochia prostrata* Roth.

Genus *Hablitzia* Bieb.

H. tamnoides Bib. - Tonus form h.

It is a liana-type perennial herb, hemicryptophyte, 150-200 cm, flowering VI-VIII. It is found in the lower and middle mountain zone, along the forest and river, on humid mountain slopes. Caucasus. (Rs.) The species is described from the Caucasus. The general distribution is the Caucasus.

Genus *Kochia* Roth

K. prostrata (L.) Schrad.

It is half a bush. Chamephyte, 10-80 cm. flowering VII-VIII. It is found in the low and middle mountain belt, in moist meadows, by



Fig. 3. *Salsola ericoides* Bieb.

S. dendroides Pall.

It is a half bush. Khamefit, 1 m. flowering V-VIII. It is found in the north of the Lesser Caucasus, in the lower and middle mountain belt, in humid meadows, by the river, Caucasus. (Sp.) The species is described from the Caucasus (on the eastern shores of the Caspian Sea). It is described from Central Asia (Fig. 4).

S. nodulosa (Moq.) Iljin.

It's a bush. Nanophanerophyte, height 20-30 cm. flowering VII-VIII. It is found in the lower and middle mountain belt, in wet meadows, on the banks of rivers. It is subendemic. Caucasus (Pl.). The species is described from the Caucasus (Salyan). The general distribution is the Caucasus.

Genus *Noaea* Moq.

the river. (R.) The species is described from North Asia. Described from Europe, Mediterranean, Southwest (Iran), Central Asia (Fig. 2).

Genus *Salsola* L.

S. ericoides Bieb.

It is bush. Nanophanerophyte, the height is 1 m. flowering V-VIII. It is common in the middle mountain belt, along the river, in humid places. The Caucasus. (Sp.) The species is described from the Caucasus (Kur coast). The general distribution is the Caucasus (Fig. 3).



Fig. 4. *Salsola dendroides* Pall.

N. mucronata (Forssk.) Aschers. et Schweinf

It is half a bush. Chamephyte, 20-60 cm. flowering V-VIII. It is found in the lower mountain belt, by the river, in humid places. Meditterian (Pl.) The species is described from Egypt. Meditterian, Southwest (Iran) Central, Asia.

Genus *Chenopodium* L.

C. botrys L.

It is an annual herb, therophyte, 20-40 cm, flowering VI-VIII. It is found in the low, middle and high mountain belt up to 1800 m, in dry river tributaries, on the roadside. Common Ancient Mediterranean (Sp.) The species is described from Europe. Europe, Mediterranean, Africa, Southwest (Iran, Himalayas, Tibet) Asia (Fig 5).



Fig. 5. *Chenopodium botrys* L.



Fig. 6. *Chenopodium foliosum* Aschers.

C. foliosum Aschers.

It is an annual herb, therophyte, 20-50 cm, flowering V-VI. In the high mountain belt (up to 2800 m) in dry rivers, roadsides. Common Ancient - Mediterranean. (Sp.)

The species is described from Europe. The distribution of general spreading is Europe, Mediterranean, Africa, South-West (Iran, Himalayan, Tibet) Asia (Fig. 6.).

Genus *Atriplex* L.

A. turcomanica (Moq.) Boiss.

It is a semi-shrub. Khamefit, 25-70 cm. flowering VII-VIII. It is found in the lower mountain belt, in moist meadows, by the river. The Caucasus. (Sp.) The species is described from Turkmenistan. It is described Southwest (Iran, Turkmenistan) Asia.

A. patula L.

It is an annual herb, therophyte, 30-50 cm, flowering VI-VIII. It is found in the middle mountain zone, along the river, in humid places. Polarctic. (Pl.) The species is described from Europe. It is described from Europe, North Africa, North America, Western Siberia, Central Asia.

Conclusion: The analysis conducted in some areas of Dashkasan region in humid meadows, river banks and high mountain ranges shows that according to their life forms, 3 shrubs, 4 semi-shrubs, 3 annual and 1 perennial grasses of the Chenopodiaceae Vent family are found. In the lower and middle mountain belt, along the river, in humid places, mainly shrubs and semi-shrubs prevail, and in the high mountain belt, the percentage of annual and perennial grasses prevails.

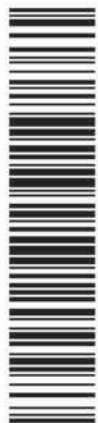
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